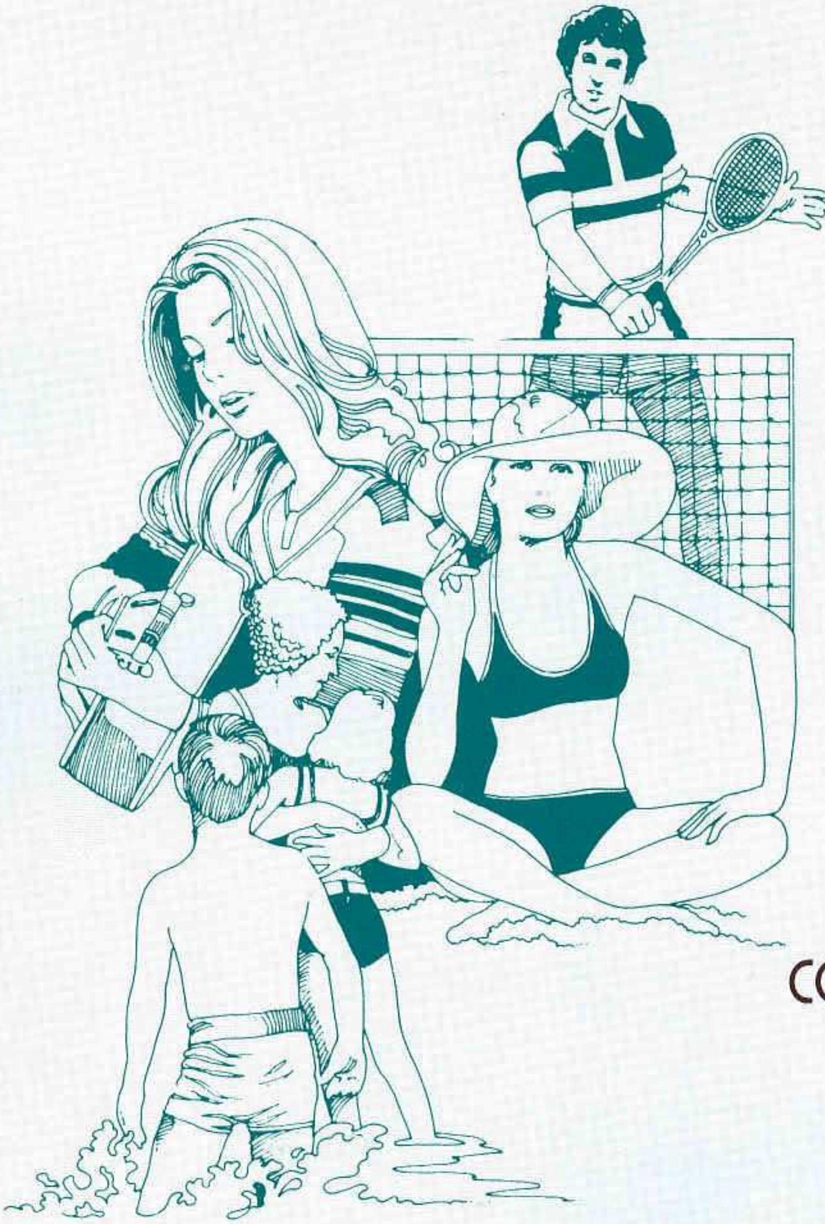
LAKE RONKONKOMA



Clean Lakes Study -1986

COUNTY of SUFFOLK
NEW YORK

prepared by:
suffolk county planning department
suffolk county department of health services
n.y. state department of environmental conservation

LAKE RONKONKOMA CLEAN LAKES STUDY

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1986

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Suffolk County Department of Health Services
Hauppauge, New York

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This document was prepared by the Suffolk County Planning Department, Suffolk County Department of Health Services and New York State Department Environmental Conservation pursuant to Section 314 of the Federal Clean Water Act (1979). This project has been financed in part with Federal funds from the United States Environmental Protection Agency under Grant C000433. The contents do not necessarily reflect the views and policies of the United States Environmental Protection Agency, nor any state, county, regional or local agency participating in the Clean Lakes Program.

Preface

Lake Ronkonkoma is the most important glacial *kettlehole* on Long Island. From its early history as part of the Vanderbilt Estate to its current public use by thousands of Long Island citizens, this centrally located lake is a unique recreational, ecological and economic resource. Unfortunately the rapid urbanization that took place during the '50s and '60s resulted in development patterns that degraded the water quality of the Lake. It also contributed to its decline as a major focal point and community resource.

It is for all these reasons that when I took office in 1980, I directed the Department of Planning to undertake a major study to see if these negative trends could be reversed. This report was prepared by the Department of Planning, in cooperation with the Suffolk County Department of Health Services and New York State Department of Environmental Conservation, with funds secured under the Federal Clean Water Act. In my judgement, the joint efforts of the three agencies have produced a superb management plan which, when fully implemented, will guarantee not only the major revitalization of the quality of the waters in Lake Ronkonkoma, but of equal importance, the achievement of a major open space program that will guarantee access to this Lake for swimming, fishing, and other enjoyable pursuits of current and future generations.

During the preparation of this plan, I have presented several resolutions to the Suffolk County Legislature for the acquisition of major parcels of land. Much has already been accomplished. I, therefore, wish to commend the Legislature for its wisdom and positive action in helping to bring this plan to reality. I am equally confident that when the Legislature studies this report, it will be equally supportive of the additional recommendations for this priceless resource.

May 1986 Peter F. Cohalan

Suffolk County Planning Commission

Acknowledgements

This Management Plan is the culmination of a collective endeavor in the best sense of that term. It is the product of an interdisciplinary effort involving a wide array of talents and expertise.

This document could not have been properly completed without the participation and support of many people whose contributions are too numerous to list here. The names of the major contributors are listed in the credits. The Suffolk County Planning Commission wishes to take this opportunity to express its sincere thanks to them and to the other unnamed individuals who have helped to make this plan a reality.

However, the Commission would like to express a special appreciation to the following: our professional colleagues Anthony Conetta and Theresa Faber in the New York regional office of the Environmental Protection Administration; John Chester - Suffolk County Commissioner of Parks, Conservation and Recreation; Suffolk County Legislators Rose Caracappa-- Chairman of the Lake Ronkonkoma Citizens Advisory Committee, Donald Allgrove, John Foley, and James Morgo; The Lake Ronkonkoma Citizens Advisory Committee (CAC), John Wehrenberg--former CAC chairman; and Roger Meeker, Richard LaValle, George Volkman, Raymond Singer of the Suffolk County Department of Public Works; and Anthony Tucci of the Suffolk County Planning Department for his excellent work in preparing the typesetting, layout and graphics of this study.

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Table of Contents

Table of Contents(Cont'd.)

Table of Contents (Cont'd.)

List of Figures

List of Tables

List of Tables (Cont'd.)

Chapter 1....

Executive Summary

1.0 PROJECT LOCATION AND BOUNDARY

Lake Ronkonkoma is located in Suffolk County, New York. Although three towns, Islip, Brookhaven and Smithtown share the two mile shoreline, the Town of Islip is the sole owner of the lake bottom under nonflooding conditions. The Lake Ronkonkoma Clean Lakes Study project area is indicated in Figure 1-1, Location Map. Lake Ronkonkoma is the largest freshwater lake on Long Island and comprises an area of approximately 237 acres under normal conditions. The lake does vary in size from approximately 215 acres during average drought periods to 275 acres during flooding conditions. The average depth of the lake is approximately 14.5 feet (4.5 meters). There are two deep holes in the southwestern section with depths of 43 ft. (13.0 meters) and 66 feet (20.0 meters). The volume of the lake is approximately 4,000,000 cubic meters.[1] (See Table 1-1 and the Bathymetric map - Figure 1-2).

A large wetland commonly known as the Great Bog is located directly north of the lake. This area was originally part of the lake and represented a shallow portion of that water body. Smithtown Blvd. (CR 16) separates the bog from the lake. A culvert under the road provides a surface water connection between the bog and the lake. Steuben Blvd. and an illegal dump separates this wetland and a freshwater marsh located to the west of Steuben Blvd. See Figure 1-3.

Table 1-1
Physical Parameters of Lake Ronkonkoma
(May 1983)

PARAMETER	LAKE RONKONKOMA
Surface Area	$960{,}000m^2$, 237 acres, 96 hectares
Lake Volume	$4{,}000{,}000m^3$
Mean Depth Z	4.5m (14.5 feet)
Maximum Depth Zm	20m-23m (66-75 ft.)
Retention Time	2.5 years
Flushing Rate	0.42 lake volumes per year
Contributory Runoff Area	300 acres

1.1 PURPOSE OF STUDY

The primary purpose of this study was to develop a comprehensive management plan for the Lake Ronkonkoma and its watershed area. This management plan includes provisions for the protection and enhancement of the lake's water quality and use, and protection of the lake shoreline and the publicly owned lands that surround the lake.

1.2 PROJECT DESCRIPTION

Chapter 1 of this study provides a summary of the lake related problems, the project findings, goals for improving conditions (water quality and general environment), and a brief summary of the recommendations.

Chapter 2 includes an analysis of the physical and biological processes, characteristics and resources of the lake and the immediate watershed area. Geology, topography, hydrology and land use activities are discussed.

Chapter 3 provides a description of past and present governmental activities and programs affecting the lake and the surrounding community. In part, this study is a continuation of park acquisition and park development studies undertaken by the Suffolk County Planning Department. The monitoring of the lake swimming areas, is a part of an ongoing program by the Suffolk County Department of Health Services.

[1] Holzmacher, McLendon and Murrell, P.C./H2M Corp., Drainage Improvements including Groundwater Relief, Phase I Feasibility Study - Volume I Basic Data and Preliminary Findings, March 1980.

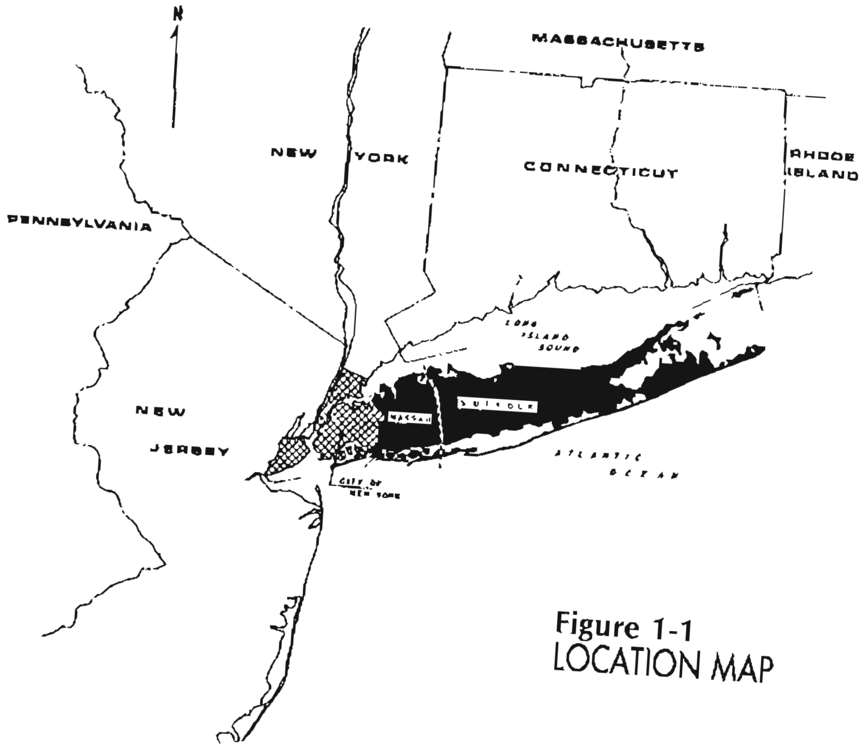
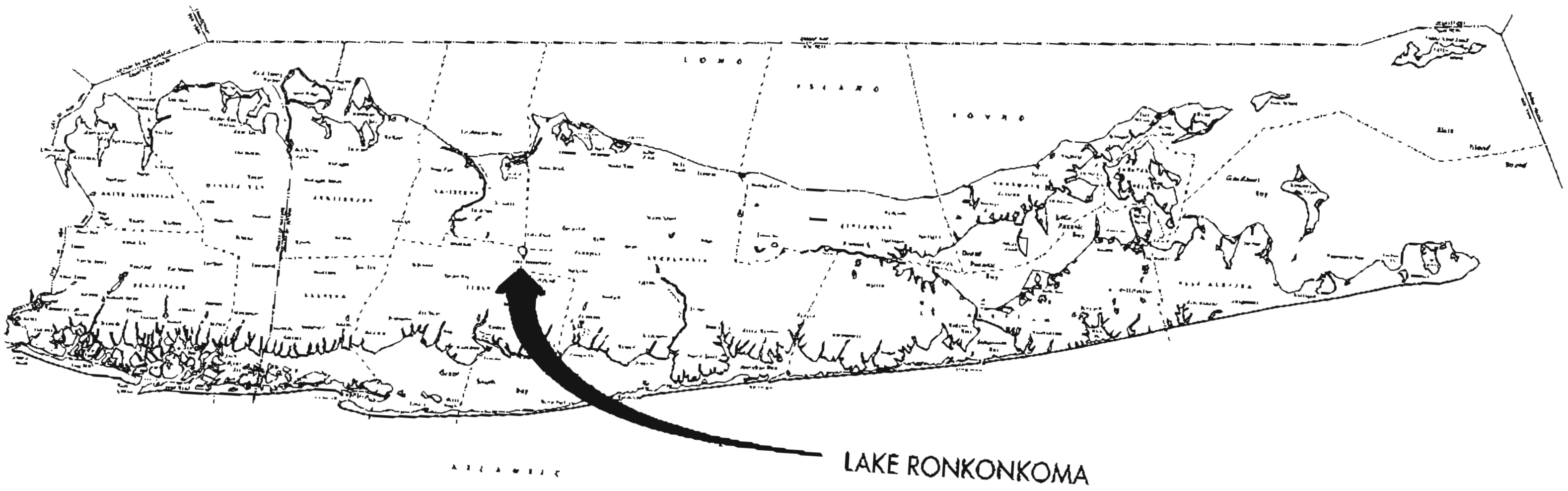
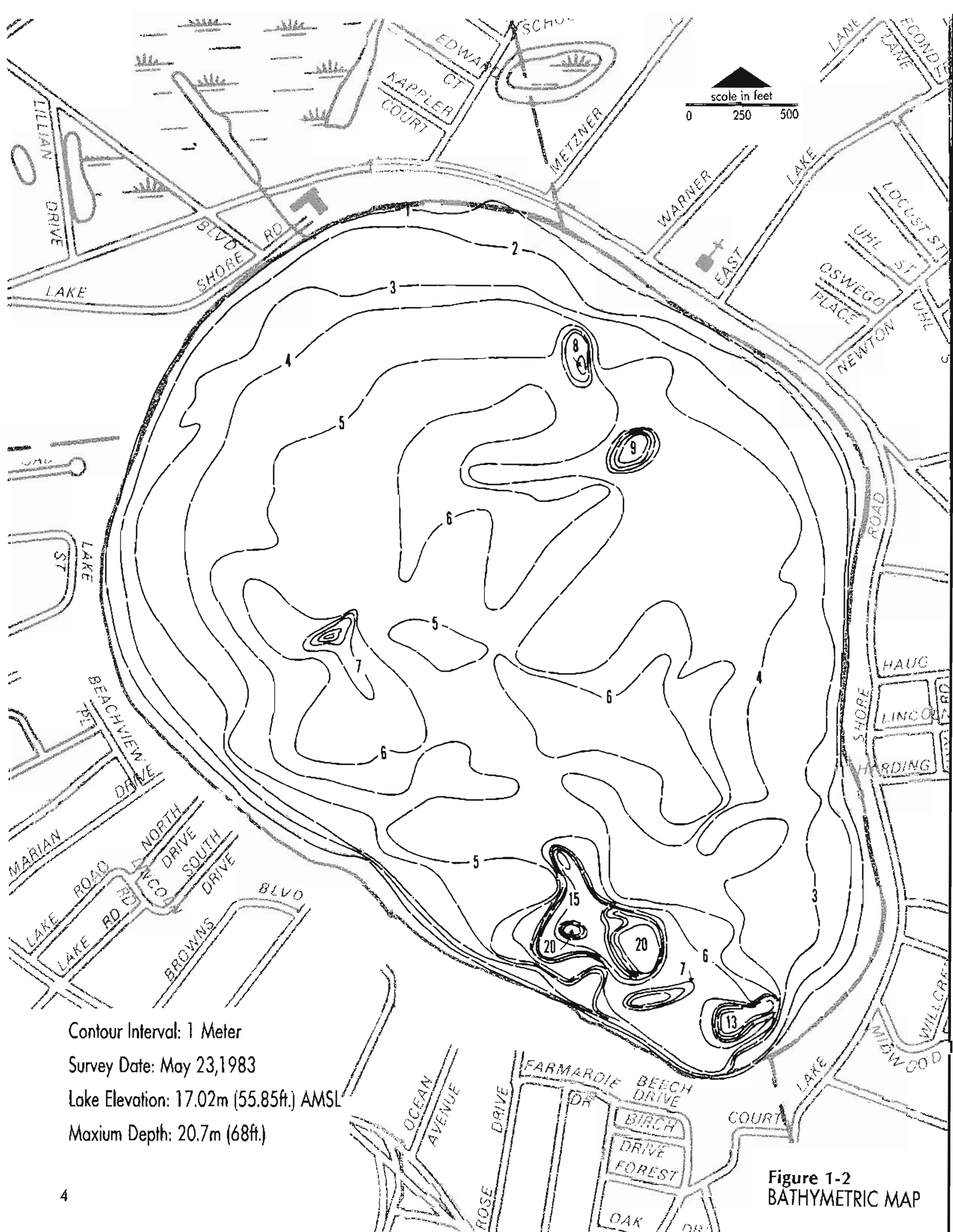


Figure 1-1
LOCATION MAP





Contour Interval: 1 Meter

Survey Date: May 23,1983

Lake Elevation: 17.02m (55.85ft.) AMSL

Maxium Depth: 20.7m (68ft.)

Figure 1-2
BATHYMETRIC MAP

Figure 1-3
LOCATION of the GREAT BOG

Chapter 4 discusses the water quality surveys of

- ambient lake water quality
- lake water quality near the shore during wet weather
- the stormwater runoff survey
- the groundwater survey.

The first study was conducted by the NYSDEC; the three latter studies were conducted by the Health Department. Each category of the water quality survey is divided into description, analysis and results.

- The first, the extensive ambient lake water quality sampling program involved the measurement of the chemical, physical and biological characteristics of the lake under dry weather conditions. The biological characteristics measured included the bacteria, phytoplankton and zooplankton.
- The second, or wet weather study was undertaken to measure changes in the ambient lake water quality during wet weather and to determine the relative impact of rainfall and runoff on the lake water quality. Fecal and total coliform bacteria and numerous chemical parameters were analyzed.
- The third, the stormwater runoff sampling program was conducted to assess the quality of the stormwater runoff entering the lake. Stormwater runoff samples were analyzed for bacteriological and chemical parameters.
- The fourth, the groundwater quality survey involved the installation and sampling of wells upgradient of the lake in order to evaluate the quality of the groundwater in that portion of the Upper Glacial aquifer that supplies groundwater to the lake.

Chapter 5 presents the analysis of the water budget for the lake. The water budget estimates average yearly inflow, outflow and storage of water for the lake.

Chapter 6 provides a detailed analysis of the water quality impacts from the inflow components of the yearly water budget to Lake Ronkonkoma. Knowledge of impact of the relative inputs upon water quality aids in the formulation of the management plan. A thorough understanding of the existing condition of the lake, its physical characteristics, the chemical composition of the water and its biological processes facilitates the development of a strategy for assuring lake water quality acceptable for contact recreation and a viable lake ecosystem.

The management plan is detailed in Chapter 7, the final segment of the report. Water quality objectives, land use objectives and recreational objectives are put forth. Land use, zoning and stormwater management controls are discussed, along with potential future acquisitions, proposed park facilities and park management recommendations. Recommendations are presented for future research and monitoring. Finally, the public participation program is explained.

1.3 PROJECT FINDINGS AND CONCLUSIONS

1.3.1 General Summary. The problems at Lake Ronkonkoma are not unique for a freshwater lake located in an urbanized area. Pollution, flooding, a high water table, destruction of vegetation, erosion, noise resulting from improper use, littering and illegal dumping, inadequate roads, and poorly designed or unauthorized access which results in erosion and destruction of vegetation are common occurrences. Some of the problems are the result of development that occurred at a time when environmental and aesthetic concerns were accorded little, if any consideration. However, most of these problems can be mitigated or controlled. A detailed description of the problems follows.

- Bacteria from stormwater runoff was identified as the water quality component likely to have the greatest adverse impact upon activities such as swimming and wading. Fortunately, it is the component that can be partially controlled by installing recharge basins or other control measures to prevent or limit the direct discharge of stormwater into the lake.

- The presence of algae (phytoplankton) in the lake is a commonly observed occurrence, particularly during the summer and early fall. The potential accrual of phytoplankton biomass depends upon quantities and proportions of usable plant nutrients (phosphorus and nitrogen) present in the lake water at any one time when light and temperature conditions are favorable. The availability of these nutrients influence the potential growth of the phytoplankton. Although the presence of algae affects lake aesthetics and visibility for swimming, algae provides the primary source of food at the base of the food chain. Either increased amounts, or greatly reduced amounts of algae could negatively affect the lake ecosystem. It would be desirable to reduce a portion of the existing phosphorus and nitrogen loads to the lake. Phosphorus loads to the lake should be reduced since phosphorus is the primary limiting nutrient for phytoplankton. At times, nitrogen is the limiting nutrient for certain types of algae. The control of other existing lake phosphorus loads (such as streamflow) is more difficult and the effects of mitigation measures would be minimal.
- Stormwater runoff is the primary source of phosphorus to the lake. The second most important source of phosphorus is direct precipitation. The stormwater control measures that are effective in controlling or minimizing bacterial loads to the lake can also be used to reduce phosphorus loads.
- Nitrate loads are considered a problem for lake water quality, as well as a major groundwater quality problem. Therefore, the recommendations include measures to reduce general nitrate loads over the long term in the study area (e.g. reduce fertilizer applications and reduce housing densities to minimize sewage discharges.)
- Incompatible land uses and activities such as commercial establishments located in residential areas occur at various places around the lake.
- The recent increased lake levels (4 to 5 feet above normal), coupled with a long history of intensive use for contact recreation has resulted in a significant degradation of the shoreline habitat.
- There is evidence of severe erosion of the southern and eastern shorelines in several areas. Since the shoreline has been submerged, a new shoreline configuration is developing. This process will recur with periodic rises and falls in the lake level. As lake levels decrease, it is anticipated that new adjustments in the shoreline will occur. Erosion may prevent the future use of portions of planned county park facilities at several locations. Any plans for the shoreline must allow for future changes in lake levels and in the changing configuration of the shoreline. Measures to secure the shoreline are probably not in order, except in the case of stormwater runoff related erosion.
- Illegal dumping is a major problem on Suffolk County parkland and within the Lake. Furniture, construction debris, remains of structures, garbage, and tires are found along the shoreline on the vacant lands and within the wetlands and the lake. Despite the fact that the plan calls for limited access along the shoreline, a park ranger on duty as required, public education for residents and park users and a neighborhood alert system; it appears that as long as it is expensive or inconvenient to dispose of household and construction related debris, some illegal waste disposal will continue. The implementation of control measures should minimize the problem.

1.3.2. Goals for Lake Ronkonkoma Study. The following goals and objectives were developed as a result of numerous meetings with other agencies and private citizens, the water quality investigations and a study of conditions surrounding the lake. The policies and programs needed to achieve the goals are included in the recommendations section.

Protect Lake Water Quality

- Reduce the existing bacterial loads to the lake.
- Whenever possible, reduce existing nutrient loads to the lake.
- Prevent any future increases in nutrient, sediment or bacterial loads to the lake.
- Prevent future illegal sanitary or other waste disposal into or adjacent to the lake.
- Prevent any new intensive land uses (commercial, high density residential, etc.) within the 300 acre area of direct stormwater runoff.
- Improve the stormwater drainage systems within the immediate lake watershed area.
- Prevent any man-made conditions that would increase the flooding problems to the lake.
- Prevent any future man-made erosion of the lake shoreline.

Protect the Wetlands

- Prevent any future damage to the bog or other freshwater wetlands.

Protect and Maintain Existing Natural Vegetation and Provide Additional Watershed Protection

- Prevent any destruction of natural vegetation, wildlife habitats or environmental resources on existing or future County parklands acquired for passive use.

Enhance the Lake Ronkonkoma Park System

- Acquire additional properties required to complete the park system.
- Improve the scenic quality of the lake area.

Provide Additional Park Facilities

- Improve pedestrian access particularily on the eastern side of the lake.

Provide Needed Controls for the New Park System

- Provide an adequate staff of park rangers to manage the Suffolk County Lake Ronkonkoma Park.
- Provide improved controlled vehicular access to the eastern shoreline of the lake.
- Prevent the use of motor bikes or other illegal vehicular use on county parklands.

1.4 GENERAL RECOMMENDATIONS

The categories of plan recommendations are listed in Table 1-2 opposite of the various management plan goals.

Table 1-2

Relationship of Plan Goals vs. Plan Recommendations

GOALS	PLAN RECOMMENDATION CATEGORIES TO IMPLEMENT GOALS
Protect Lake Water Quality	
•Reduce the existing bacterial loadings to the lake.	Stormwater runoff management
•Whenever possible, reduce existing nutrient loads to the lake.	Stormwater runoff management, fertilizer use and turf management
•Prevent any future increases in nutrient, sediment or bacterial loads to the lake.	Zoning recommendations; Stormwater runoff management; Proposed acquisitions; Septic system management; Right of first refusal; Fertilizer use and turf
•Prevent future illegal sanitary or other waste disposal into or adjacent to the lake	Existing health code, increased inspections
•Prevent any new intensive land uses (commercial, high density residential, etc.) within the 300 acre area that contributes direct stormwater runoff to the lake.	Zoning recommendations; Right of first refusals; Proposed acquisitions; Parkland and facilities management recommendations
•Improve the stormwater drainage systems within the immediate lake watershed area.	Stormwater runoff management
•Prevent any man-made conditions that would increase the flooding problems associated with a rise in lake levels.	Zoning recommendations; Parkland and facilities management; Stormwater runoff management
•Prevent any future man-made erosion of the lake shoreline.	Stormwater runoff management
Protect the Wetlands	
•Prevent any future impacts upon the Great Bog or other freshwater wetlands.	Parkland and facilities management; Stormwater runoff management
Protect and Maintain Existing Natural Vegetation and Provide Additional Watershed Protection	
•Prevent any destruction of natural vegetation, wildlife habitats or environmental resources on existing or future County parklands acquired for passive use.	Parkland and facilities management; Proposed acquisitions
Enhance the Lake Ronkonkoma Park System	
•Acquire additional properties required to complete the park system.	Proposed acqusitions
•Improve the scenic quality of the lake area.	Parkland and facilities management
Provide Additional Park Facilities	
•Improve pedestrian access, particularily on the eastern side of the lake.	Parkland and facilities management; Proposed acquisitions
Provide Needed Controls for the New Park System	
•Provide adequate park rangers to manage the Suffolk County Lake Ronkonkoma Park.	Parkland facilities management
•Provide improved controlled vehicular access to the eastern shoreline of the lake.	
•Prevent the use of motor bikes or other illegal vehicular use on county parklands.	

Chapter 2....

General Background and Present Conditions

2.0 GENERAL BACKGROUND

Lake Ronkonkoma was first used by Long Island Indians as a fishing station and meeting place. As early as 1685, white colonists first purchased land from the Indians and settled in the area. Then in the late 1800's, the railroad brought many wealthy and famous people out to the lake, and it became the *playground of the affluent.* From the early 1900's to the 1930's, the increased use of the automobile brought additional people to the lake, and it became a highly developed and prosperous summer resort.

After World War II, many people established year-round residency, and widespread development took place. During the 1960s a severe drought caused a general five to ten foot lowering of the water table in the Lake Ronkonkoma area. At the same time a building boom occurred resulting in the development of the woodland areas as well as sites that were unsuitable for building because they were located in wetlands, and/or normally had a high water table. This development caused a decrease in the extent of pervious areas within the of watershed and an increase in the volume of stormwater runoff to the lake. During the years following the drought, the recurrence of normal rainfall patterns led to a rise in the water table level and the flooding of numerous basements (north, west and northeast of the lake). In some instances, even the first floors of homes located north of the lake were inundated with water.

Certain portions of the lake were filled and developed. The northern portion of the lake was formerly located where Smithtown Boulevard (CR16) now separates the lake from the bog. This road was developed in the 1930s. The area south of CR16 and north of the lake and the Old Causeway (Lake Shore Road) was also filled in and developed. The development of Steuben Boulevard required the filling in of the shallow portion of the lake and adjacent wetlands. The western shore was also filled using dredged material from the lake.

During recent periods of flooding, in 1979 and 1984, the lake and the Great Bog became one body of water breached by Smithtown Boulevard.

See Appendix G for aerial photography taking during a 50 year span of Lake Ronkonkoma and vicinity.

2.1 PHYSICAL CHARACTERISTICS OF THE LAKE RONKONKOMA STUDY AREA

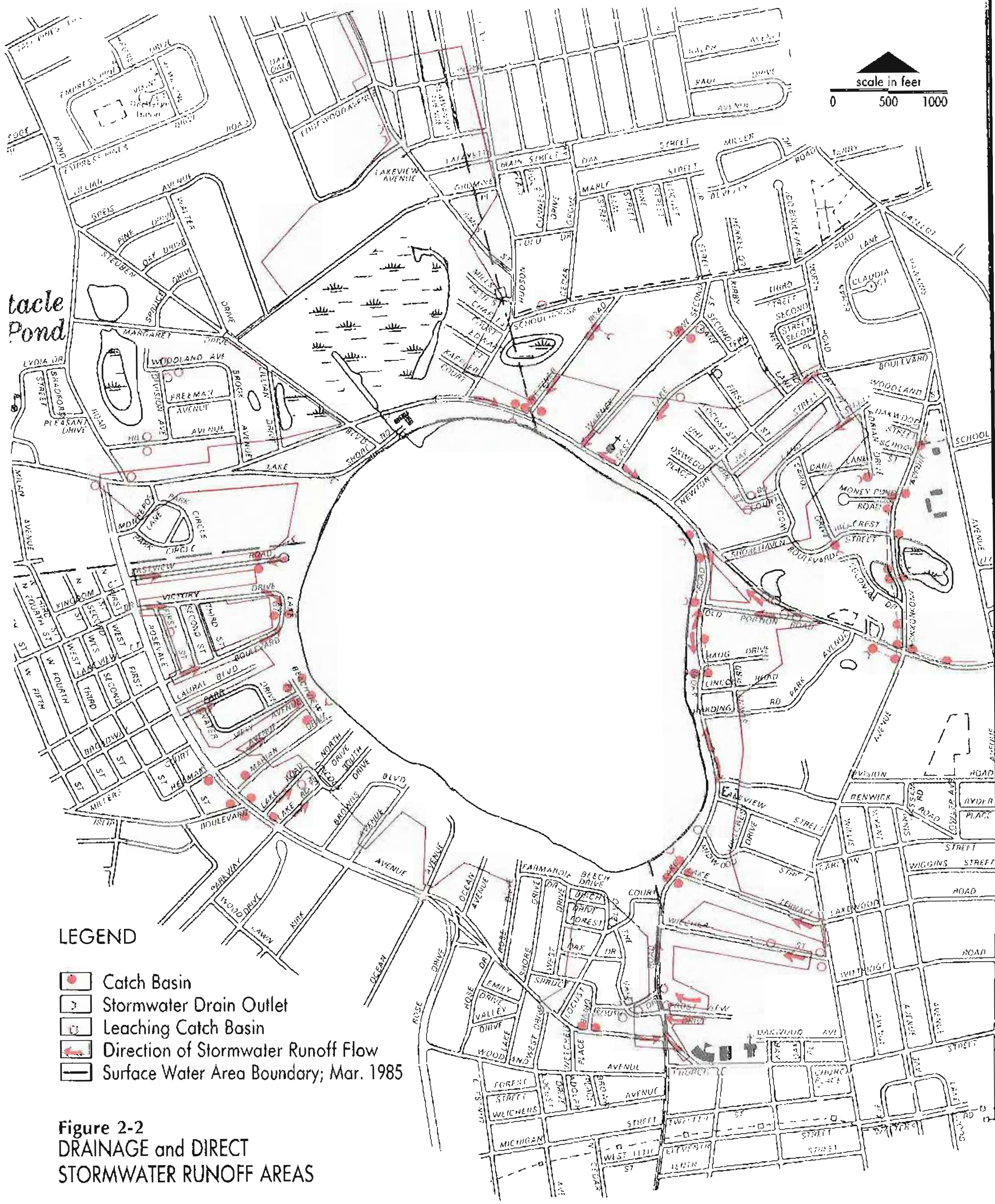
2.1.1 Watershed Boundary. The overall watershed area and the area immediately surrounding the lake that contributes stormwater runoff to the lake are illustrated in Figures 2-1 and 2-2.

2.1.2 Geology. Lake Ronkonkoma is classified as a glacial kettlehole that was probably formed by a large block of ice that became detached from the glacial front. When the block melted, it left a depression, which filled with water. This glacial ice sheet had moved to the middle of Long Island (south of the lake), and stopped, leaving a central ridge or terminal moraine, the *Ronkonkoma Moraine.* The glacier then retreated north of Long Island and then readvanced stopping along the north shore and creating the *Harbor Hill Moraine.* While morainal deposits lie to the north and south of the lake, the area surrounding the lake is mainly composed of glacial lake deposits and an outwash plain. The outwash plain consists of water-bedded sand and gravel deposits and lake deposits, which include clayey materials and silts. The Ronkonkoma basin (See Figure 2-3) is the largest lacustrine deposit on Long Island (see Groundwater).

2.1.3 Groundwater. Figure 2-3 illustrates the subsurface geology in the area of the lake, and displays the configuration of the three groundwater aquifers; the *Upper Glacial*, the *Magothy* and the *Lloyd aquifer.* Beneath and directly north of the lake is the *Ronkonkoma basin,* an extensive subsurface valley, which extends through the Upper Glacial aquifer to the Magothy Aquifer.

The lake, the Great Bog and the wetlands north of the lake are supplied by the same groundwater system. Water level elevations in the lake, bog and wetlands are generally consistent with groundwater levels near the lake. The groundwater flow system on Long Island is separated by a groundwater divide which extends approximately across the center of the Island in an east-west direction. Lake Ronkonkoma is approximately two miles south of the regional groundwater divide. The water recharging north of the divide flows in a northerly direction towards Long Island Sound. Water recharging south of the divide generally flows in a southerly direction carrying groundwater from north of the lake (See Figures 2-4 and 2-5) to the lake and towards the

Figure 2-1
WATERSHED AREA



LEGEND

- Catch Basin
- Stormwater Drain Outlet
- Leaching Catch Basin
- Direction of Stormwater Runoff Flow
- Surface Water Area Boundary; Mar. 1985

Figure 2-2
DRAINAGE and DIRECT
STORMWATER RUNOFF AREAS

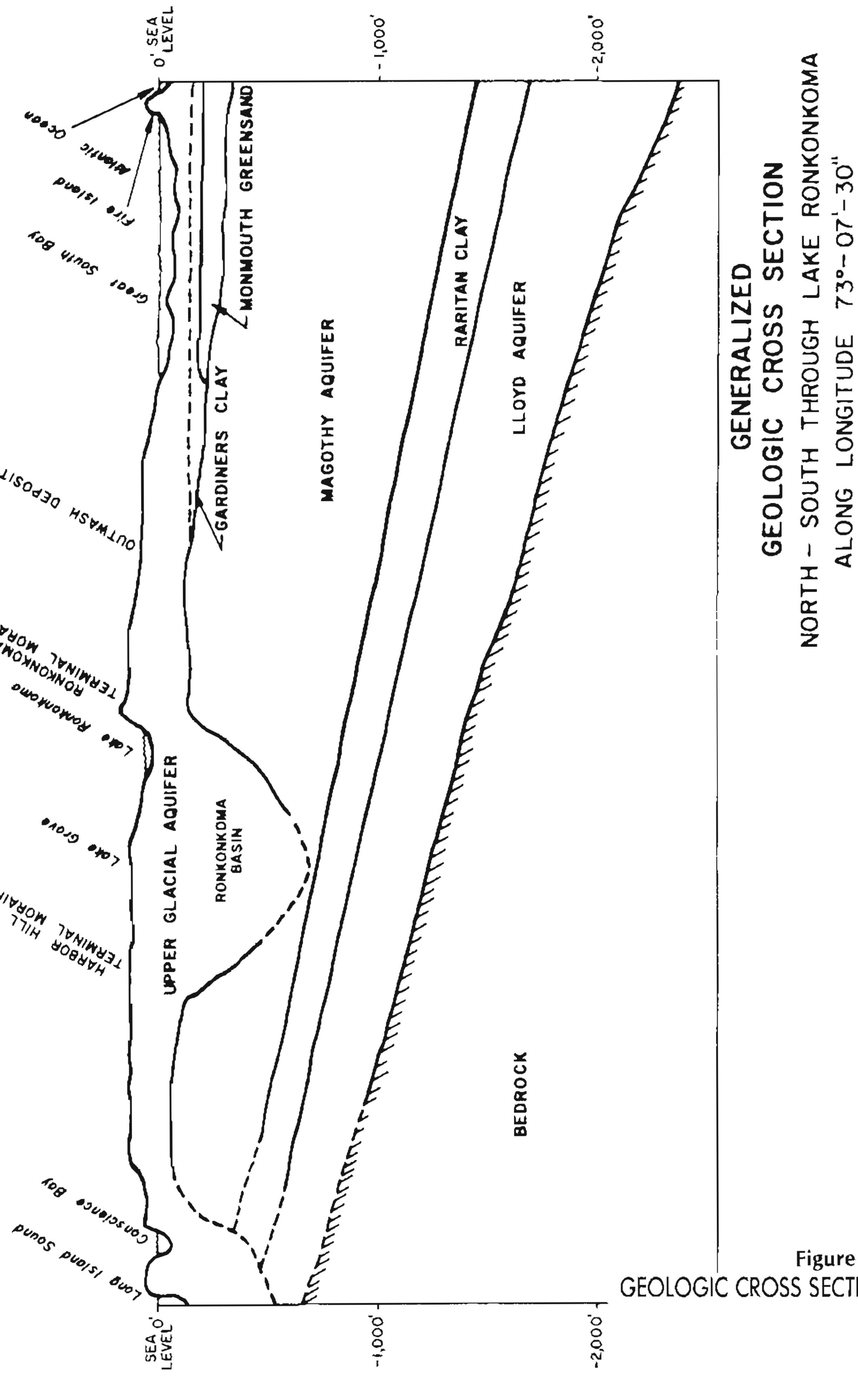


Figure 2-3
GEOLOGIC CROSS SECTION

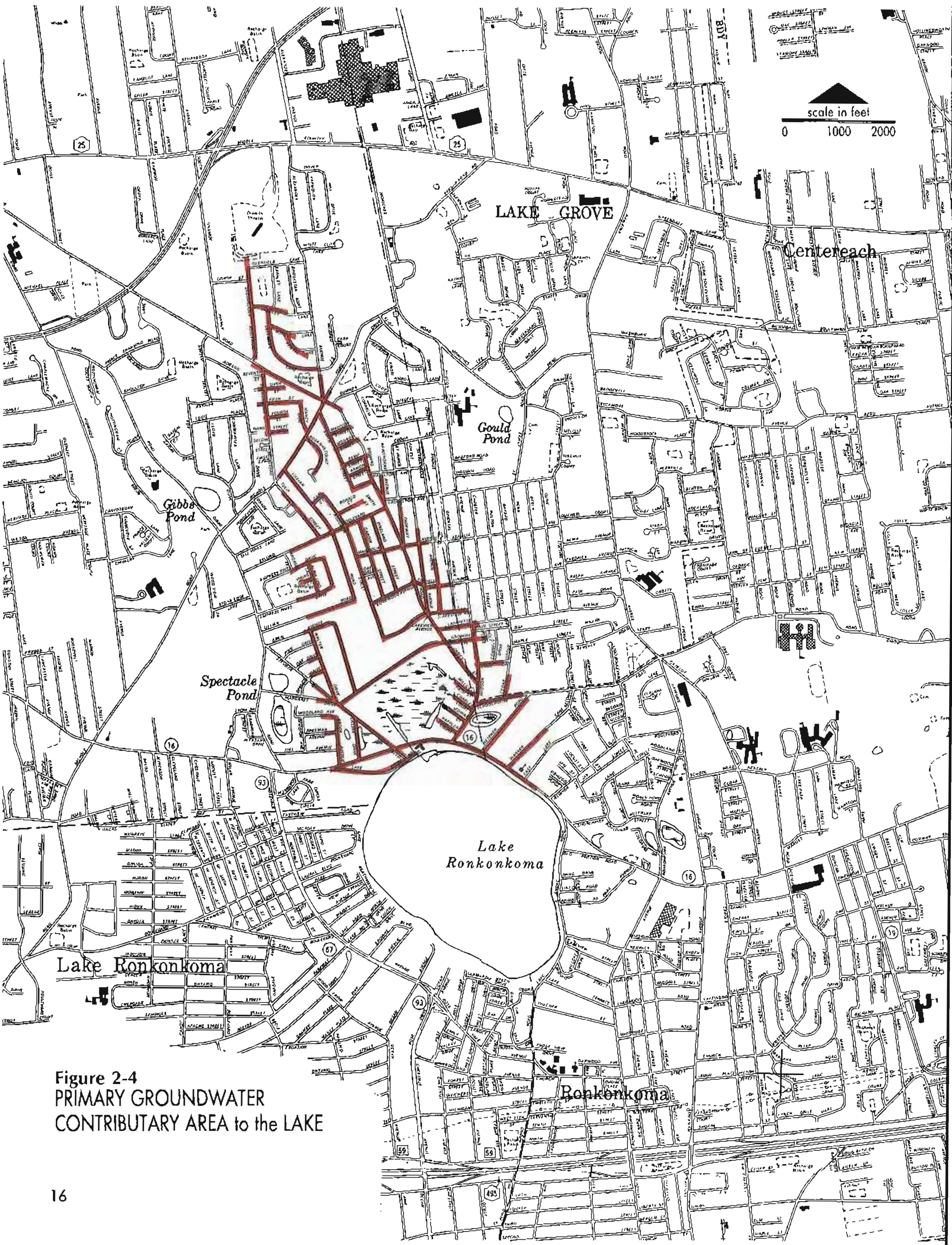


Figure 2-4
PRIMARY GROUNDWATER CONTRIBUTARY AREA to the LAKE

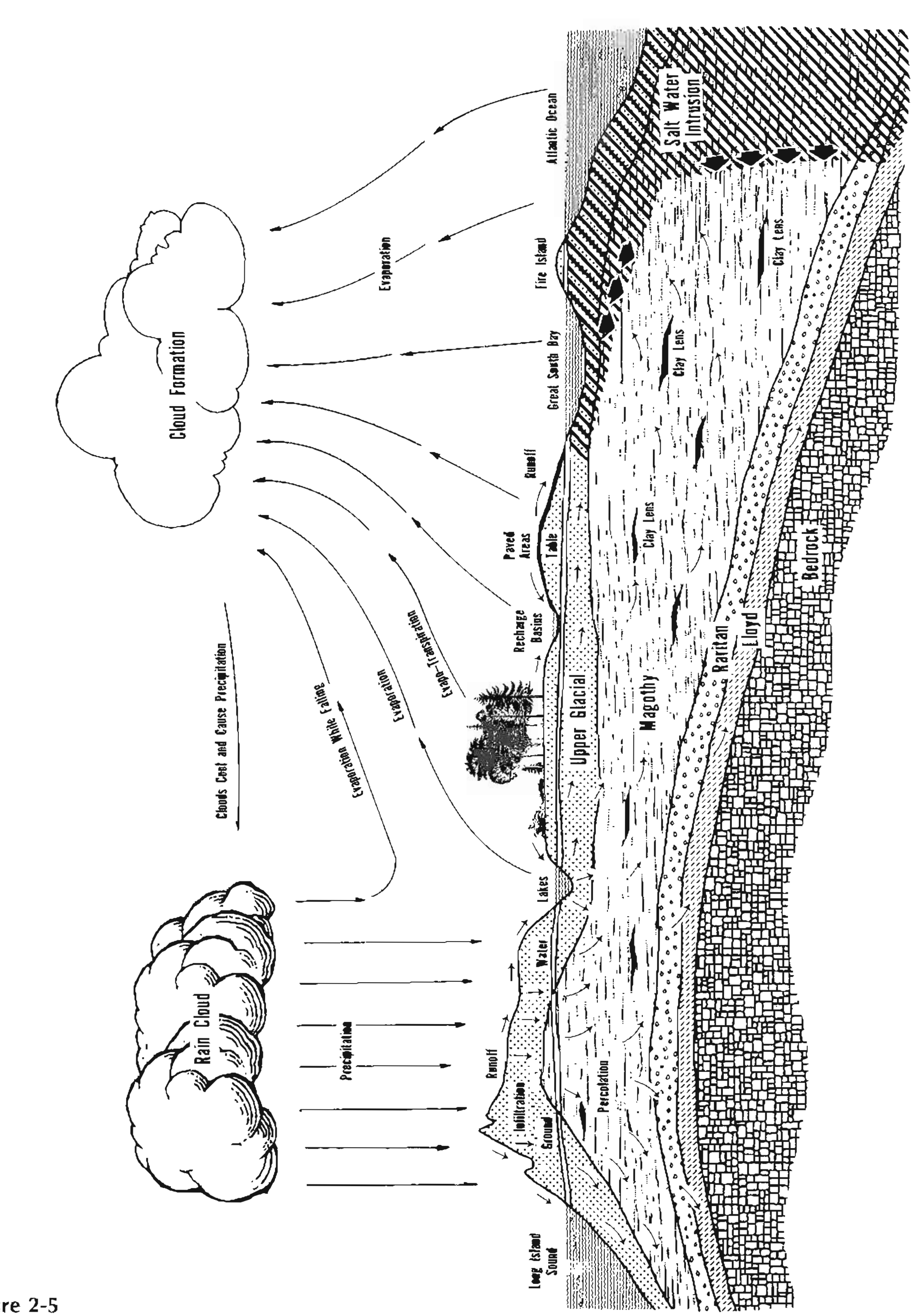


Figure 2-5
The LONG ISLAND AQUIFER SYSTEM

Great South Bay and Atlantic Ocean. Groundwater flow into the lake occurs when the head or pressure in upgradient portion of the aquifer system is greater than the water level of the lake. (See Hydrology for a discussion of sources of water to the lake and losses of water from the lake.) In 1984, the lake gained water faster than water was discharged from the lake into the Upper Glacial aquifer. This was due to the higher than average precipitation which also resulted in increased stormwater runoff,increased groundwater and stormwater pumpage from the Smithtown recharge basins (See Figure 2-6).It is possible that mounding occurs at the lake during periods of flooding, and the lake may have received a smaller proportion of its total inflow from groundwater underflow during this time.

The primary groundwater contributory area to the lake with its origin at the regional groundwater divide is shown in Figure 2-4. The predominant land uses contained in this area are residential (2-4 dwelling units/acre) and open space and water (a large County holding that includes a woodland and the bog.) (See Land Uses).

Groundwater levels in the general area around the lake tend to fluctuate in a manner somewhat similar to the level of the lake. However, following a storm, lake levels will continue to increase for several days, while groundwater levels near the lake will increase only slightly. Groundwater levels upgradient of the lake are not as responsive as the lake to short term changes in precipitation.

During the drought of the 1960's, former wetland and high water table areas were filled in and subsequently developed. As a result, the natural hydrologic system was disturbed. Ground water levels and lake levels have increased dramatically since that drought. Due to a rise in groundwater and lake levels in 1979, and a recurrence in 1984, many of these developed areas are experiencing extensive flooding problems. Today, as many as seventy homes in the general area have flooded basements, and roads near the lake are periodically flooded. There are approximately fifty additional acres adjacent to the lake that are flooded during periods when lake levels are high.

The residential area north of the lake near the intersection of Nichols Road, Browns Road and Alexander Ave. has had chronic flooding problems. During the early seventies, three recharge basins serving this residential area of Smithtown were interconnected by a system of gravity piping and discharged, via a pump station and force main, about one-half mile south into the Great Bog, west of Browns Road. (See Figure 2-6).

2.1.3.1 Groundwater Quality. Groundwater quality data obtained from sampling at monitoring wells installed for this project and at existing wells of the SCDHS observation wells network are presented in Chapter 4.

2.1.4 Hydrology

2.1.4.1 Water Budget for the Lake. The water budget is an estimate of the quantities of water entering and leaving the lake, based upon the formula: **Inflow = Outflow + Change in Storage.** During equilibrium conditions the volume of inflow and outflow is the same, so there is no change in storage. At times of drought, storage decreases; and during period of heavy rain storage increases. See Chapter 5 for a detailed description of the water budget for Lake Ronkonkoma.

2.1.4.2 Sources of Water to the Lake. The inflow to Lake Ronkonkoma comprises the following sources of water:

- groundwater underflow from areas upgradient (north) of the lake
- surface water inflow (stream base flow, stream wet weather flow and pumpage from three recharge basins north of the lake)
- direct precipitation falling upon the lake area and upon the water surface of the Great Bog
- stormwater runoff from approximately 300 acres of the immediate watershed area. (See Figures 2-6 and 2-7 and Table 5-2 for volumes).

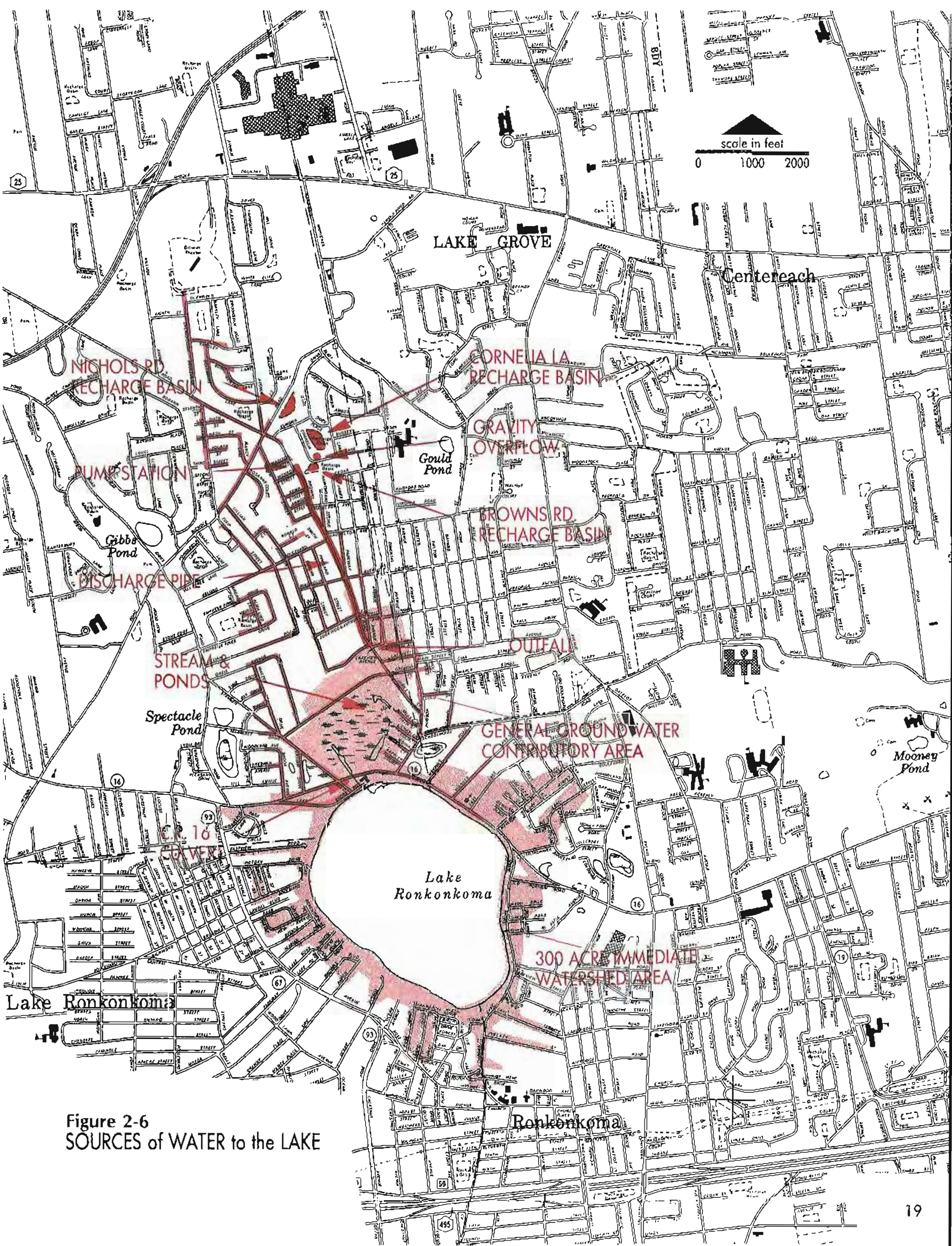


Figure 2-6
SOURCES of WATER to the LAKE

Figure 2-7
STORMWATER RUNOFF
CONTRIBUTARY AREA

2.1.4.3 Losses of Water From the Lake. Lake Ronkonkoma does not have any surface water outlets; therefore, there are only two processes by which water is lost (outflow) from the lake. They are evaporation and groundwater underflow. From year to year, the amount of loss associated with these two processes remains fairly constant, regardless of the amount of rainfall and the changes in lake levels. Hence, during a year of higher than average rainfall, the elevation of the lake will increase, and, during a year of lower than average rainfall, the lake level will decline.

2.1.4.4 Precipitation. The central portion of western Suffolk County receives the greatest amount of yearly precipitation. The mean annual precipitation in the immediate vicinity of the lake is approximately 50 inches. Annual precipitation was above average in 1975, 1976, 1977, 1978, 1979, 1983 and 1984. (Wet weather sampling for the project began on March of 1983 and the stormwater runoff sampling began during August of 1983. The groundwater monitoring began in May of 1984 when groundwater elevations were approaching an all time high.)

2.1.4.5 Stormwater Runoff

2.1.4.5.1 Description. Stormwater runoff is one of the major sources of water and pollutant loads to the lake. (See Chapter 5 and 6). Stormwater runoff is that part of the total precipitation that flows over the land surface. During and following a rainfall, a portion of the stormwater flows to lower elevations within the watershed area where it percolates into the soil and is either taken up by plants, recharged to groundwater or drains to the wetlands and lake. The amount of runoff from a watershed area depends upon the

- storm characteristics
- type and amount of vegetative cover
- type and amount of impermeable surface
- soils and soil permeability
- slope characteristics
- type and capacity of natural and man-made stormwater drainage systems

Within the primary watershed area, stormwater runoff enters the lake either from direct overland flow, from stormwater drainage systems that discharge directly into the lake and from wet weather stream flow from the bog into the lake.

2.1.4.5.2 Stormwater Runoff Surface Drainage Area. The drainage patterns of the area are primarily governed by the topography. In the flatter, undeveloped areas runoff velocities are relatively slow, thus allowing increased percolation and a reduction in volume. In contrast, on the steeper slopes and in developed areas runoff is more rapid and the volume greater. (See Topography).

Suffolk County Planning Department and the Suffolk County Health Department have delineated a Stormwater Runoff Surface Drainage Contributory Area for Lake Ronkonkoma, which includes approximately 300 acres of land around the lake and the Great Bog (See Chapter 4 for a detailed description and Figure 2-7). Approximately twenty percent of the precipitation falling upon this area reaches the lake. The remaining eighty percent of the precipitation is either lost to the atmosphere, directly as evaporation from the 300 acre watershed area and from the surface of the lake-including the process of plant uptake and evapotranspiration or as percolation through the soils to groundwater. Stormwater falling upon areas beyond the 300 acres does not reach the lake unless it becomes a part of groundwater flow or is pumped from the three Smithtown recharge basins.

2.1.4.5.3 Key Problems Related to Stormwater Runoff. Stormwater runoff is a transport vehicle for contaminants deposited on impermeable and/or semi-permeable surfaces. Since the contaminants become incorporated in the runoff and are carried to the surface waters, stormwater runoff is often an important contributor to surface water degradation.

As the Lake Ronkonkoma watershed area become increasingly urbanized, the extent of natural stormwater recharge areas decreased and the types and amounts of pollutants generated by land use activities increased. A large percentage of the natural vegetation was replaced with impervious and modified pervious surface areas. Some of the sites were developed without provision of land area for the recharge of stormwater or erosion control measures. Over time, these activities resulted in increased volumes and rates of runoff, accelerated erosion and sedimentation. To compound the problem, many wetlands were filled and developed, further reducing the storage area for stormwater, and the associated sediments and contaminants. Increased runoff created the need for more extensive drainage systems to prevent the accumulation of water in streets and highways and in flood-prone areas. The runoff from CR 16 west of School House Road is presently being discharged into the lake and the Great Bog. In some areas, among them East Shore Road and areas west and south of the lake, impermeable paving exists without curbing. Here runoff reaches the lake by overland flow, with a consequent increase in sedimentation and erosion. Biofiltration ponds were later installed on both the eastern and western sides of the lake to trap some of the pollutants from very small watershed areas. They were intended to reduce bacteria, heavy metals and inorganic nutrients reaching the lake. Unfortunately the biofiltration ponds as installed are ineffective. (See Biofiltration Ponds).

Stormwater drainage systems and curbing were installed along Rosevale Avenue, and in a few other areas near the lake. The curbing helped to reduce erosion and directed the runoff towards various recharge basins. The recharge basins, installed in areas where percolation into the subsoils can occur, do receive a considerable percentage of the stormwater within the greater watershed area; therefore, preventing stormwater from reaching the lake. Stormwater directed into recharge basins or deposited on soil surfaces may cause a small increase in the concentrations of certain contaminants in groundwater beneath the recharge basin, however, the impact is much less than if stormwater were to be discharged directly into the lake. The stormwater - borne viruses and bacteria deposited in the recharge basins or on the soil are reduced by natural die-off and by competition with soil microflora, inactivated by drying, or further limited by other factors. Movement of the bacteria into groundwater is generally impeded by the filtering effects of the soil and by adsorption to clay particles in the soil.

The Long Island segment of the *Nationwide Urban Runoff Project (N.U.R.P.), Long Island Regional Planning Board* (LIRPB), 1982 contributed to a better understanding of the impacts of stormwater runoff upon groundwater and surface water quality on Long Island. The study determined that stormwater runoff contaminant concentrations measured in groundwater beneath the studied recharge basins were generally low for most of the constituents analyzed. In most cases, they fell within the permissible range for potable water.

A portion of this study involved the monitoring of bacterial counts in stormwater runoff at discharge points to fresh water streams and ponds, and to estuarine waters. Monitoring was undertaken at the ponds, streams and bays during and following rainfall events. It was estimated that stormwater runoff accounted for at least 93% of the total and fecal coliform discharged into receiving waters.

The ratio of fecal coliform bacteria to fecal streptococci (FC/FS) is often used to give some indication of the possible sources of bacteria. The relatively low ratios for stormwater runoff in residential areas of Long Island in the NURP study were attributed to the presence of wastes from animal populations, including waterfowl, and domestic animals rather than human sources. Although it is felt that this condition is common throughout the study area, the data are not sufficient to permit identification of any individual source or combination of sources.

Stormwater runoff has been associated with high concentrations of bacteria and the consequent closing of shellfishing areas and, occasionally, beaches. Coliform bacteria are usually not pathogenic to humans; however, when present in high concentrations, they are an indication that *pathogens*, harmful to humans may be present. When confined to storm drainage systems, runoff containing pathogenic organisms generally poses little direct threat to public health, since stormwater is not ingested. However, when stormwater enters surface waters it can become a problem. The number of bacteria or viruses that can cause infection vary widely. Although thousands of viable bacteria may be needed to cause infection in humans, it is assumed that a single virus particle is an infective dose. Even though an infection occurs, it may not lead to disease, since the onset of disease is also dependent upon the age, general health and degree of immunity of the host.

There are also chemical contaminants that are associated with stormwater runoff. Nitrogen and phosphorus from fertilizers, animal wastes, duck farms and other sources may enter surface waters. Nutrients can alter the balance of freshwater systems. See Chapter 4.

The discharge of organic material in stormwater runoff can result in the depletion of oxygen. The depletion of oxygen can result in the death of species that can not survive at lower oxygen levels. The most widely used measure of organic pollution in surface waters is *biochemical oxygen demand* (BOD_5). This laboratory procedure measures the dissolved oxygen required by microorganisms in the biochemical oxidation of organic matter. When high BOD_5 loads are discharged to surface waters, the resultant depressed oxygen levels eliminate those species that cannot survive at low oxygen levels. Aquatic life changes over time as high oxygen demanding species are replaced by those that can tolerate lower dissolved oxygen (D.O.) levels.

Grease and oil products can be detected in runoff from many areas. High concentrations of salts from salt piles and highway deicing may also impact aquatic vegetation and aquatic ecosystems.

Organic chemicals from commercial, institutional, industrial, residential and agricultural uses may also be present in stormwater runoff. In some instances heavy metals (i.e. lead, zinc, cooper, and cadmium, etc.) may also be found in high concentrations in runoff. Water quality impacts of the lake are summarized in Figure 2-8.

2.1.5 Topography[1]. In most areas surrounding the lake, slopes range from three to eight percent. Those areas north of and directly adjacent to the lake are generally flat (0-3 percent) slopes. There is a steep slope area located south and east of the lake. In general slopes include swales or natural drainage areas that drain into the lake.

2.1.6 Soils[2]. The primary soil types around the lake are listed in Table 2-1.

Table 2-1

Soil Types Adjacent to Lake Ronkonkoma

Bc	Beach
PiA	Plymouth Loamy Sand 0-3% slopes
PiB	Plymouth Loamy Sand 3-8% slopes
RdB	Riverhead Sandy Loam 3-8% slopes
RhB	Riverhead and Haven Soils 0-8% slopes
CUB	Cut and Fill Land, gently sloping
CpE	Carver and Plymouth Sands 15-35% slopes
Mu	Muck (wetland soil type)
Ma	Made Land

See Recommendations Appendix E,Table 3 Limitations of the Soils for Development

2.1.7 Natural Resources. Several wetlands located north of the lake were described under Chapter 1. Numerous acres remain in oak pine woodland and in secondary growth woods. Some of the lands have been disturbed by the unsupervised operation of motor bikes and by illegal dumping. The lake contains numerous species of finfish and is a popular fishing area for local fisherman. (See Figure 2-9 for the Natural Resource Inventory.)

2.1.8 Lake Ecosystem. The appropriate means of understanding Lake Ronkonkoma, along with the surrounding wetlands and watershed area is to view it in the context of an ecosystem. An ecosystem is not only composed of the plant and animal populations and environment of an area, and encompasses the total nutrient and energy cycles of a system. Ecosystems are self-contained and self-maintained. They are dynamic, changing in space and time, with an enormous number of interactions constantly evolving.

[1]United States Department of Agriculture, Soil Conservation Service, Soil Survey of Suffolk County, New York, April 1975.
[2]Ibid

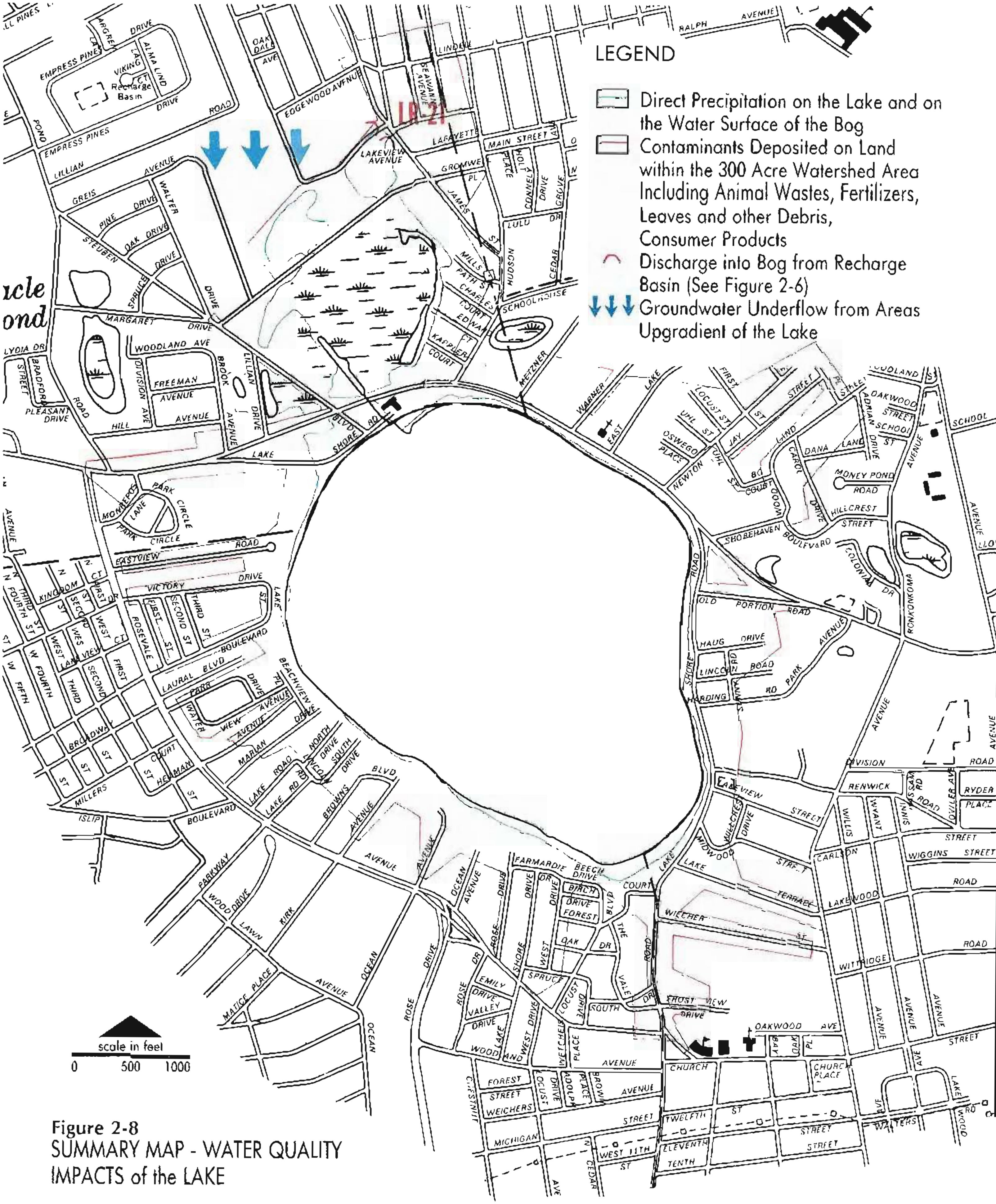


Figure 2-8
SUMMARY MAP - WATER QUALITY IMPACTS of the LAKE

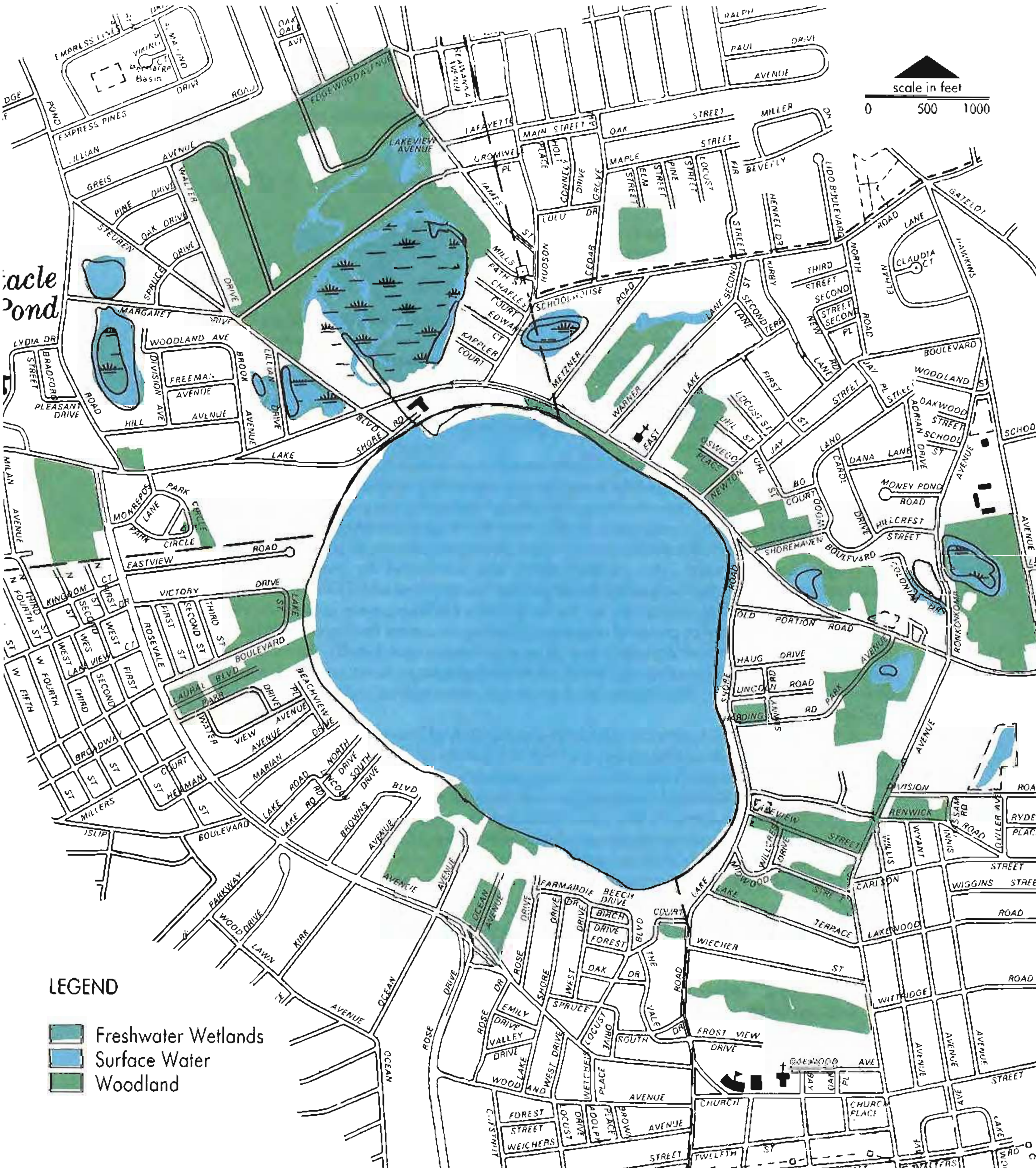


Figure 2-9
NATURAL RESOURCES MAP

There are two processes involved in the scheme and organization of an ecosystem:

- the flow of energy
- the cycling of materials

Lake Ronkonkoma can be considered an aquatic ecosystem with three fundamental components:

- the physical environment
- the chemical environment
- the biotic community

Long-term regional climate and short-term local climate directly influence the physical environment, which includes the water temperature, light intensity and duration, and wind generated turbulence. The chemical characteristics of the water are derived from the geological drainage basin and its organic composition and the land use and human activities in conjunction with the lake's hydrology. The biotic community of the lake integrates the physical and chemical environment, and manifests the nature of the ecosystem components,in measureable quantities; species composition and abundance.

The biotic community is the most readily recognizable aspect of the lake's ecosystem and is the focal point for assessing the lake's quality and discerning problems. The organization of the biotic community is two tiered consisting of producer and consumer organisms. The proliferation of a biological system requires a basic trophic level that traps solar energy and synthesizes food. In an aquatic ecosystem, this production function is relegated to minute plants, the *phytoplankton* (i.e. algae and diatoms). The phytoplankton are consumed by small invertebrates, the *zooplankton,* which, in turn, are eaten by large invertebrates and small fish. These organisms are then eaten by larger fish, and so on, up the food chain. Each sequence in the food chain can be viewed as a trophic level or group of organisms feeding on similar food sources. The food chains constitutes the pathways along which energy and nutrients travel. Finally, the nutrient cycle must be completed by organisms that can break down complex organic molecules and material from plant and animal tissue. This is done by microscopic decomposer organisms, such as bacteria and fungi.

A lake ecosystem is highly complex with a multiplicity of interacting factors constantly evolving. Complete and exhaustive analysis of the multiplicity of dynamic interactions is not often possible, practical or even necessary for lake management purposes. Community characteristics, such as species diversity, composition and abundance, combined with physical, chemical and hydrologic measurement yield information useful in determining the eutrophic status of a lake. The value of the ecosystem concept in lake management lies in its utility as a working framework for addressing lake problems. It can assist in identifying sources of problems and helping to predict the probable consequences of present or future activities within the lake watershed area.

2.1.9 Land Use. Figure 2-10 Shows existing ownership patterns surrounding the lake overlayed on an aerial photo (4-21-84) while Figure 2-11 depicts the existing land use within the study area. The greater part of the area directly adjacent to the lake is in open space, comprising county and town parkland (See Figure 2-12). A few vacant lakeside parcels remain in private ownership, but are recommended for county acquisition. Most of the recent Suffolk County acquisitions, including the largest holding, will remain undeveloped; however, two of the county properties will be developed in the near future. (See Figure 2-12). The Brookhaven and Islip Town Parks are located on the south side of the lake. Which includes a swimming beach. Some private citizens who live near the lake swim at privately owned beach association sites. A number of other vacant parcels still remain in the general watershed area. Figure 2-13 depicts the county and town parcels.

The lake is still a year-round recreational facility. During the summer, swimming, boating (non-motor), hiking and picnicking are popular. While ice skating and ice boating are popular in the winter, fishing occurs year-round.

Figure 2-10
EXISTING PROPERTIES ADJACENT to the LAKE; Photo 4-21-84

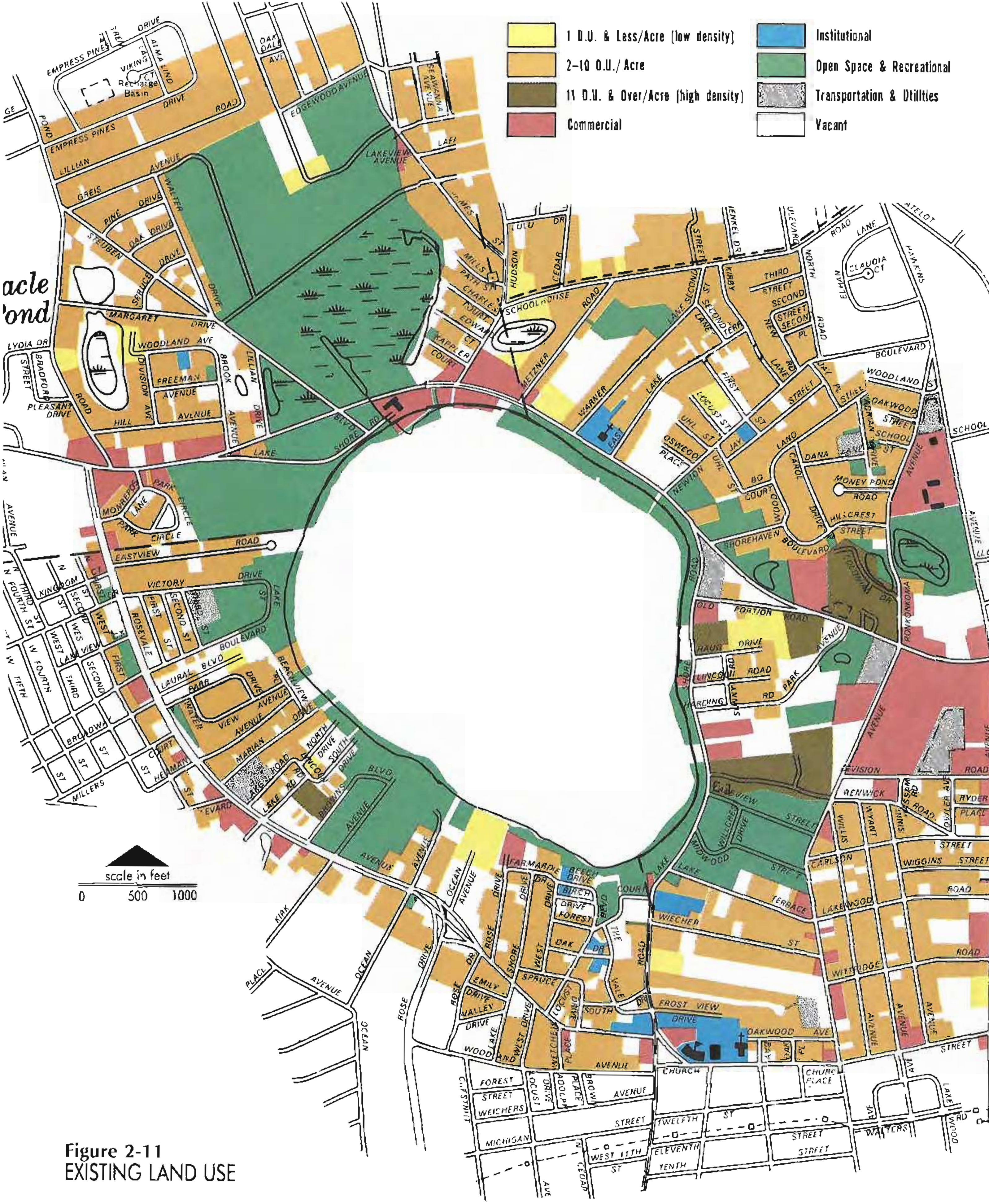


Figure 2-11
EXISTING LAND USE

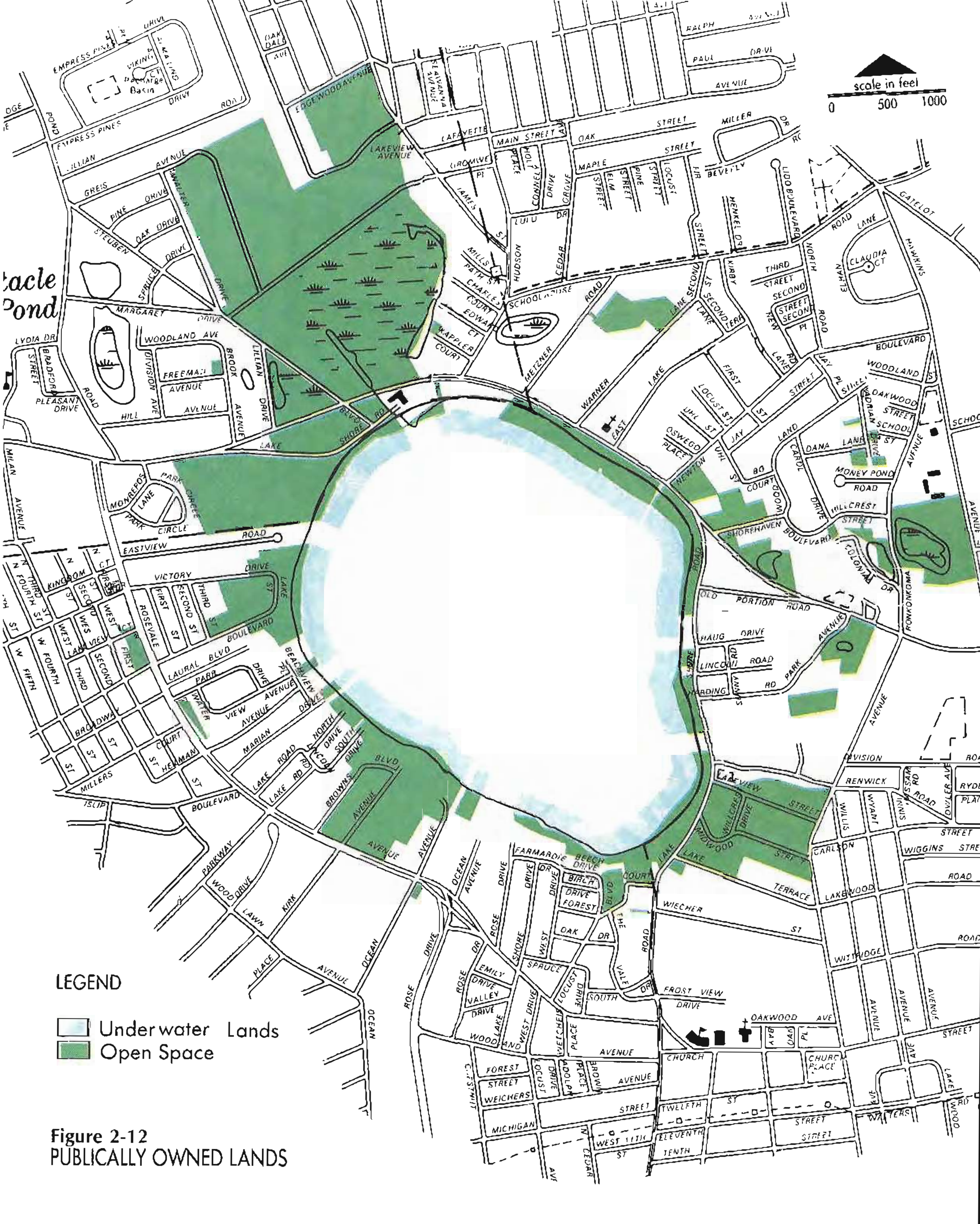


Figure 2-12
PUBLICALLY OWNED LANDS

Figure 2-13
VACANT LAND WITHIN
the STUDY AREA

The general watershed area surrounding the lake is developed. Land use within the lake's watershed is fairly consistent throughout the area. The predominant use is medium density residential at two to four dwelling units per acre. There are a few scattered low density residential areas (one dwelling unit or less per acre), which may be remnants of the estates that were common in this area in the early 1900's. In addition there are some scattered high density residential areas (5 to 10 dwelling units per acre). Approximately ten percent of the properties remain vacant. Commercial and institutional uses occur near the lake. There are also several schools and churches in the area.

2.1.10 Zoning. The Lake Ronkonkoma study area, as previously mentioned, is located in three different towns. Therefore, the zoning classifications and the permitted uses within these classifications differ slightly from town to town. (See Figure 2-14). The existing zoning classification of vacant parcels is shown in Figure 2-15.

The portion within the Town of Smithtown is located directly north and northwest of the lake. The major zoning classification in this area is residential (≥10,000 sq. ft.). However, lands located along Smithtown Blvd. (CR 16) and Rosevale Ave. and those lands south of CR 16 and directly adjacent to the lake are commercially zoned.

The portion within the Town of Islip is located west and south of the lake. The major zoning classification is residential (≥7,500 sq. ft.). There are also three other residential zoning classifications in this area (≥20,000 sq. ft., ≥15,000 sq. ft. and ≥11,250 sq. ft.). Most of the commercially zoned lands are located along Rosevale Ave.; however, there are two large parcels located along the lake shore. One of these large sections is owned partly by the town and partly by the County and will not be developed for commercial use as long as it remains in public ownership.

The portion within the Town of Brookhaven is located east of the lake. The major zoning classification in this area is also residential at various densities (≥22,000 sq. ft., ≥15,000 sq. ft. or ≥9,000 sq. ft.). There is a large amount of commercially zoned land along the major roadways: Lake Shore Road, Portion Road and Ronkonkoma Ave. The entire lakeshore in Brookhaven is commercially zoned, with the exception of one parcel that is zoned and operated as a nursing home. Although the lands directly adjacent to the Lake are zoned for commercial uses, few will actually be used in that manner because the County owns several parcels in this area.

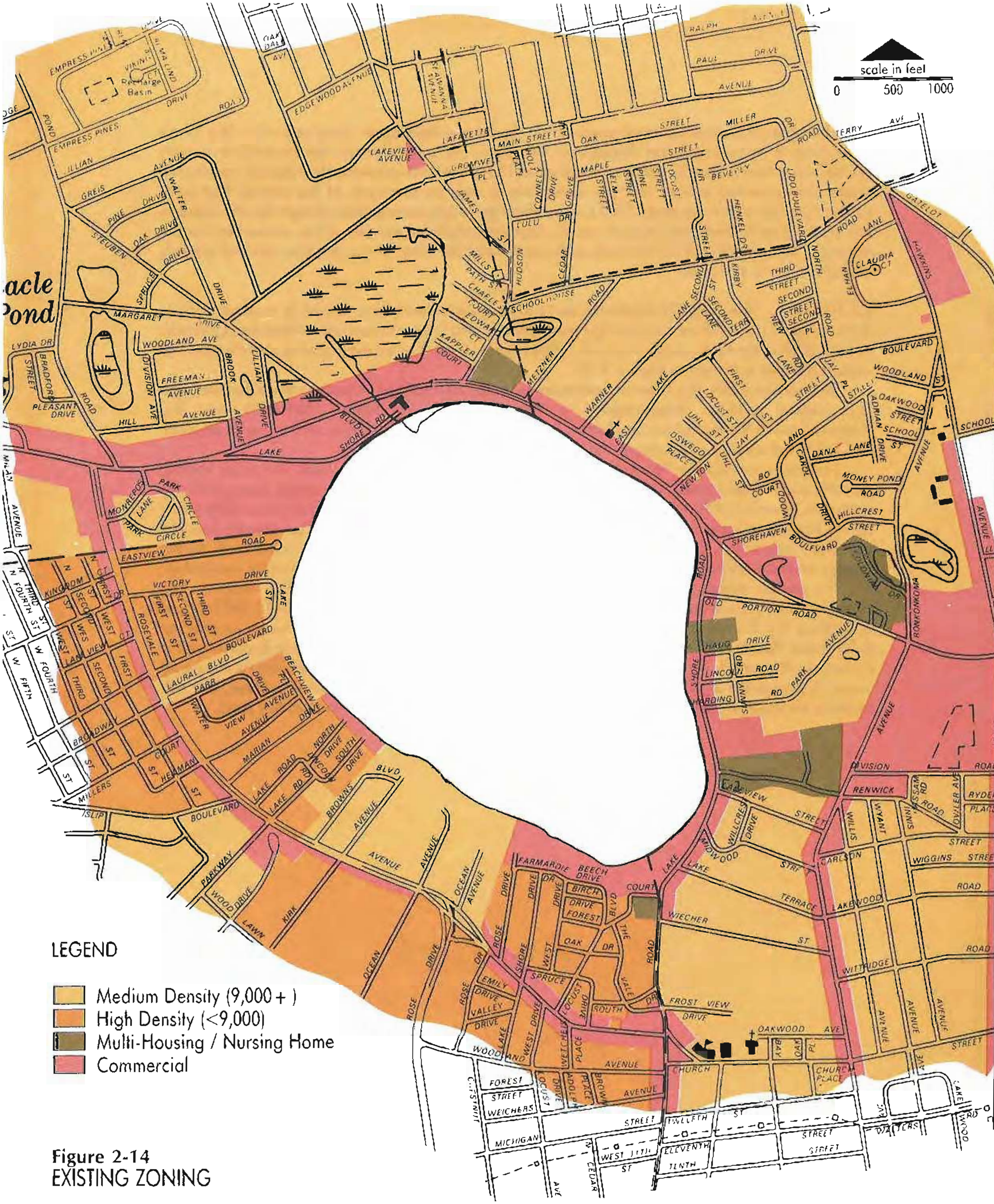


Figure 2-14
EXISTING ZONING

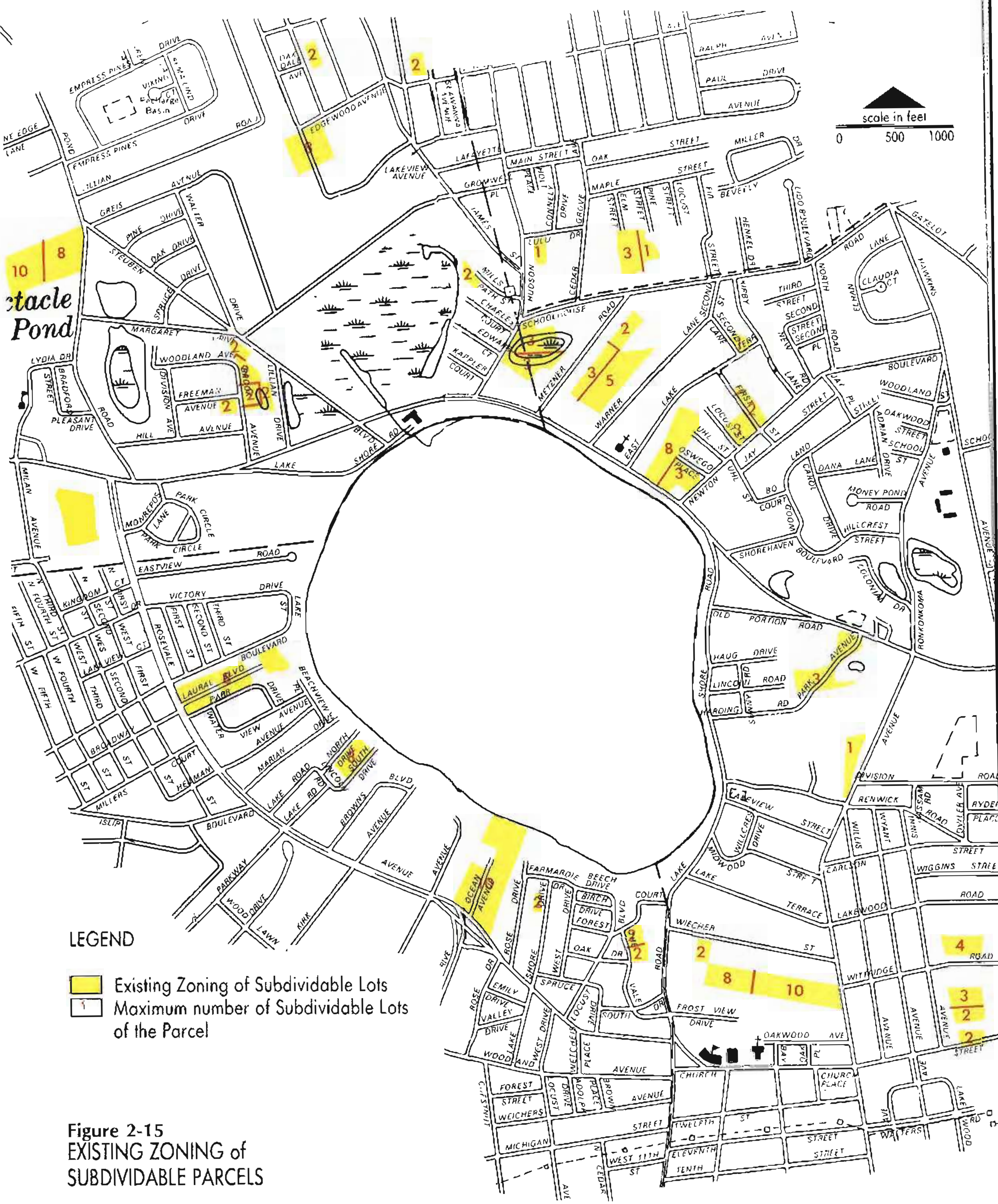


Figure 2-15
EXISTING ZONING of
SUBDIVIDABLE PARCELS

Chapter 3....

Programs and Studies Affecting Lake Ronkonkoma Programs

3.1 PROGRAMS

3.1.1 County Acquisition Program. The County has been in the process of acquiring lands at Lake Ronkonkoma for the past fifteen years. To date, approximately 185 acres have been acquired. (See Figure 3-1). Most of these lands are located directly adjacent to the lake. The County's main goals for acquisition were to provide an open space system surrounding the lake, to develop several properties for active recreational purposes and to minimize the amount of development that would be situated along the lake, thereby, minimizing the pollutant loads impacting the lake. Most of these County-owned lands will be maintained in their natural state and used for passive recreation.

The County recently reviewed its existing holdings, identified additional parcels needed to complete the park program, and is currently acquiring these lands as part of a second taking at Lake Ronkonkoma. (See Table 3-1 and Figure 3-2). A subsequent review has identified seven more parcels to be included in the third taking at Lake Ronkonkoma (See Recommendations).

3.1.2 County Parkland Development and Management. There are two large County holdings, one located northwest of the lake and south of CR 16 (Parcel A See Figure 3-3) and one located southeast of the lake and immediately north of Lake Terrace (Parcel B See Figure 3-4) which will be developed for active recreation.

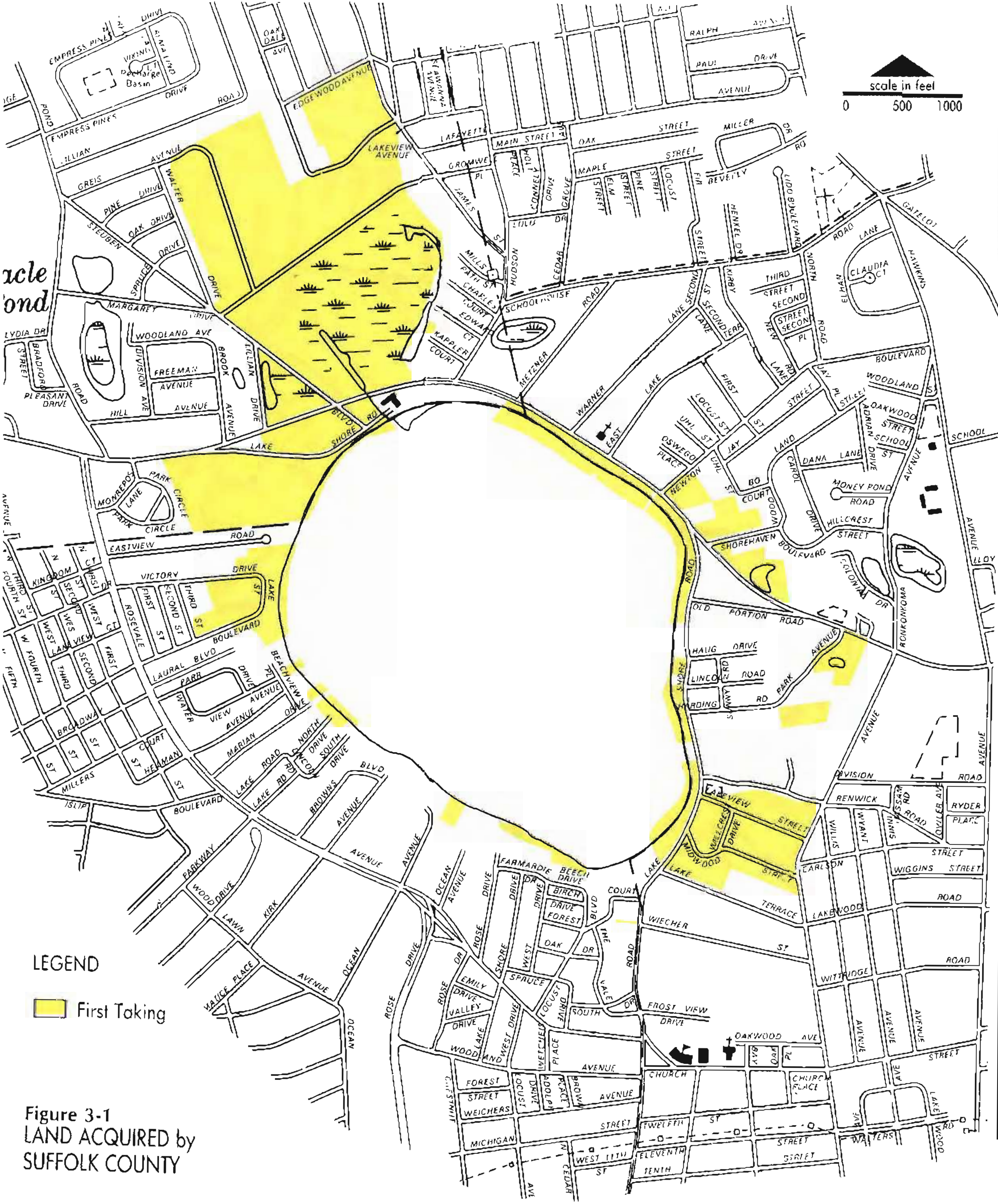
Parcel A will be developed with softball fields, picnic areas, basketball and handball courts, a small boat launching area and a *walking beach*. This parcel will also contain a small park headquarters building, including a ranger station. Parcel B will have a softball field, basketball and handball courts, a children's play area, picnic area and an overlook with a view of Lake Ronkonkoma.

Schematic plans for these two sites were developed by the Planning Department several years ago. (See Lake Ronkonkoma Citizens Advisory Committee). The engineering drawings are presently being prepared by a private consultant.

The management and development strategies for these properties differ, depending on the size and characteristics of the property. The main concern with the properties that are located directly adjacent to the lake is access, erosion and bank stabilization. Public access will be discouraged at the locations requiring stabilization. There will be a few properties that will be used as scenic overlooks and for limited parking on Lake Shore Drive. A group of parcels located at the end of Blythe Road will be used for stormwater control. The large County holding located directly north of the lake, commonly known as the Great Bog, will be managed as a nature preserve area. Due to the fragile nature of this area, only limited passive recreational use will be permitted. The park ranger located at Parcel A will be instrumental in assuring proper park use and management.

3.1.3 Lake Ronkonkoma Citizens Advisory Committee. The Lake Ronkonkoma Citizens Advisory Committee was formed in the early 1970's. It was established in order to provide an opportunity for public participation in the acquisition process. The Committee is made up of local citizens, county officials from the Parks, Public Works and Planning Departments, local town officials, and local legislators. Meetings were originally held on a regular basis in order to assure full participation in the decisions on key parcels recommended for acquisition and parkland use and protection.

At present, meetings are held whenever key issues require discussion. The Committee also reviews other projects and addresses important issues associated with the lake and its environs. The Committee reviewed the *Five Year Recovery Action Plan* (Peter F. Cohalan, 1982) which included park plans for County owned properties at the lake. The Lake Ronkonkoma Management Plan was also reviewed by the committee. In addition, the County makes presentations and provides subsequent updates of studies being conducted at the lake. During these meetings citizens often discuss important issues in order that they may be addressed as part of current studies or through the acquisition process where appropriate.



LEGEND

First Taking

Figure 3-1
LAND ACQUIRED by
SUFFOLK COUNTY

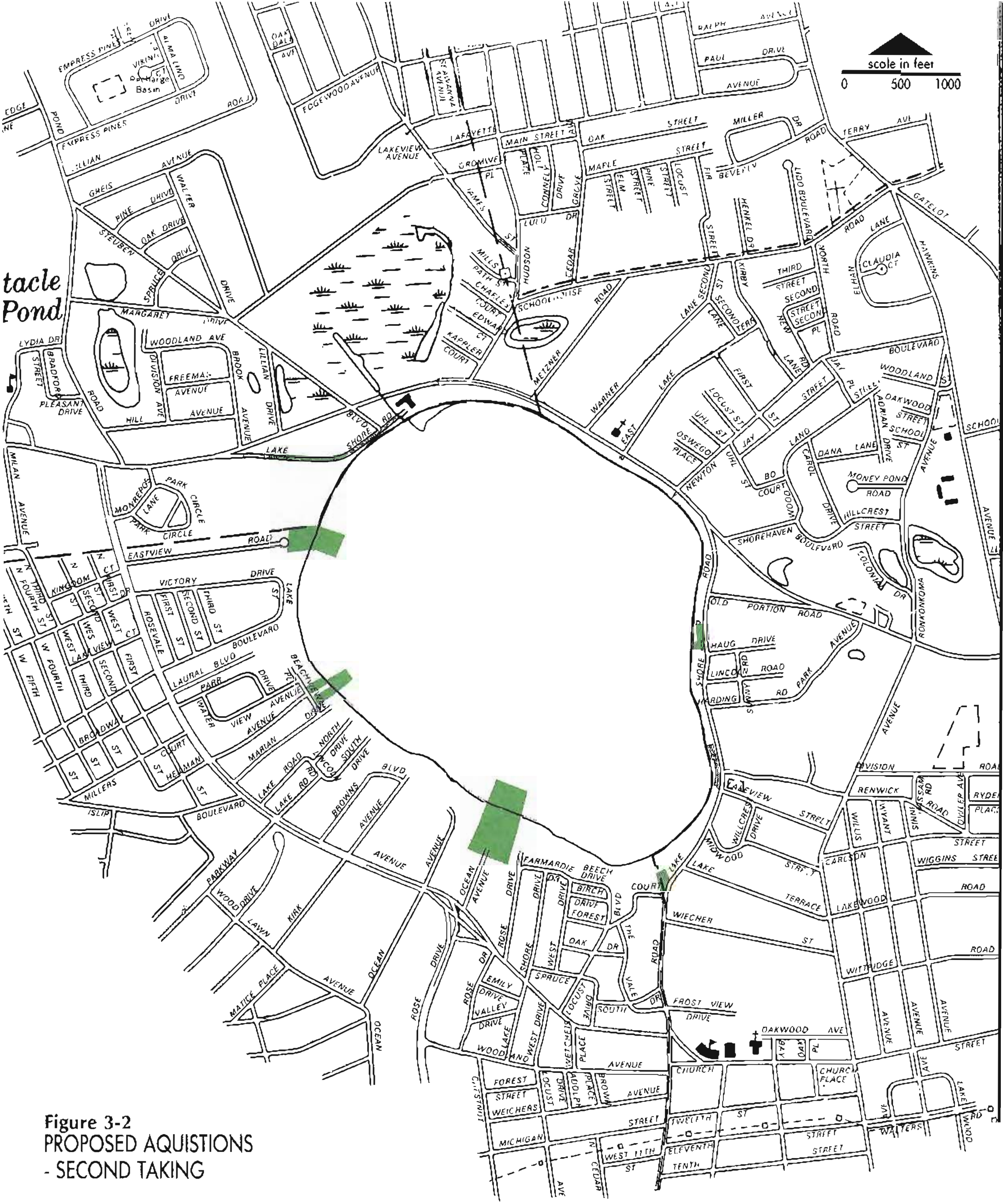


Figure 3-2
PROPOSED AQUISTIONS
- SECOND TAKING

Table 3-1

Phase II Acquistion at Lake Ronkonkoma

INTRO-RESOLUTION #1166-84

TAX MAP No.	TAKING MAP No.	CURRENT OWNER	ACREAGE
1a. 0800-171-05-	A	Town of Smithtown (Road)	1.691
2a. 0200-688-01-022	152	Lakehaven Equities, Incorporated	1.108
3a. 0200-688-05-038	151	El Am Realty Corp.	1.051
0200-688-05-040	150	Konkoma Realty Ltd.	.611
		TOTAL	4.461

INTRO-RESOLUTION #1167-84

TAX MAP No.	TAKING MAP No.	CURRENT OWNER	ACREAGE
1. 0500-010-01-047	143	Eastview Prop.	1.127
0500-010-01-048	143	Owners Assoc.	1.469
2. 0500-010-03-050.004	147	Suffolk County*	.434
0500-010-03-050.006	144	Suffolk County*	.381
0500-010-03-072.002	144	Suffolk County*	.332
0500-010-03-050.007	146	Waterview Heights	.382
0500-010-03-050.008	145p/o	Beach Assoc.	.094
3. 0500-021-03-070	148	Fullscope Inc.	3.376
-081 p/o		Fullscope Inc.	1.742
4. 0200-724-01-030	149	Cook, Walter	
0500-022-02-052		(total)	.187
5. 0200-646-02-015	153	Jay Newton Owners Association	.132
6. 0200-646-01-		Town of Brookhaven (Ext. of Lake Terrace)	.045
		TOTAL	10.312

*1984 Tax Acquired Property

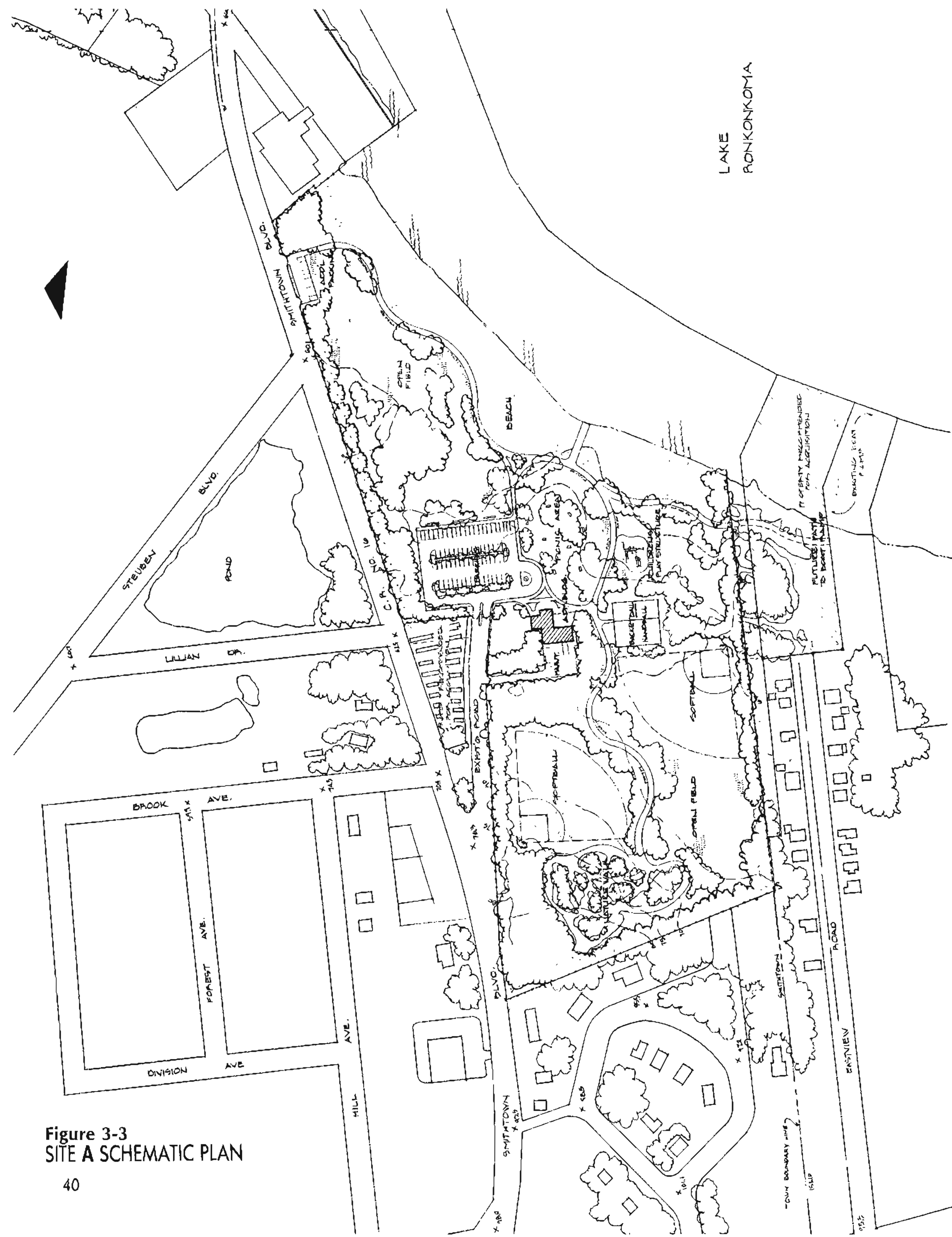


Figure 3-3
SITE **A** SCHEMATIC PLAN

Figure 3-4
SITE B SCHEMATIC PLAN

3.1.4 Suffolk County Department of Health Services Monitoring Programs

3.1.4.1 Groundwater Monitoring Wells. The Health Department has been engaged in a comprehensive program for monitoring groundwater resources. Utilizing county personnel and equipment, several hundred groundwater monitoring wells have been installed since the inception of the program. This network of monitoring wells serve a variety of purposes. These include determination of water table elevations and the direction of groundwater flow, detection of changes in ambient groundwater chemical quality, surveillance of known or suspected contamination sources, delineation of chemically contaminated groundwater plumes (such as those emanating from landfills), assessment of potential reclamation projects, and special studies (i.e., FANS, Aldicarb contamination, Consumer Products Study and the Lake Ronkonkoma Study).

This monitoring well network included ten wells within the vicinity of Lake Ronkonkoma prior to the beginning of this study (See Figure 3-5). Four of the wells were upgradient (north) of the lake and six were downgradient (south) of the lake. The six downgradient wells contained groundwater that indicated the impact of intense residential development, with relatively high nitrate-nitrogen levels and trace concentrations of organic chemical . Samples from the four upgradient wells, by comparison, only occasionally contained high nitrate-nitrogen concentrations.

To supplement the monitoring well network, five additional upgradient monitoring wells were installed specifically for this study. The location of these wells and the monitoring results are discussed in detail in this report (Chapter 4).

3.1.4.2 Private Monitoring Wells. The private water supply well sampling program provides individual homeowners with information regarding the quality of water from their wells. Private well surveys are also used to supplement monitoring well data in characterizing areas of the Upper Glacial aquifer. A recent (5/85) sampling survey of private wells at twelve homes on two streets immediately north of the lake, detected a nitrate-nitrogen concentration above the public drinking water standard in one well. Traces of organic chemicals were detected in three wells.

3.1.4.3 SCDHS Bathing Beaches. The SCDHS samples in excess of 200 bathing beaches for total and fecal coliform bacteria. From March to August 1985, the Islip Town Beach and Brookhaven Town Beach were each sampled on approximately twenty occasions. Although there were individual samples with elevated bacterial counts, the results from the series of samples for that period were within New York State Sanitary code requirements. As a result, there was no request from the SCDHS to close either beach to bathers.

3.1.4.4 Sewage Disposal Systems. The SCDHS promulgates standards for the construction of all sewage disposal systems within Suffolk County. Compliance with the standards is assured by an inspectional program and the issuance of a certification that all systems have been constructed in accordance with the code. These standards allow for some variation in the construction of sewage disposal systems depending upon soil type, depth to water and other conditions that may necessitate a particular design in order to permit proper functioning. The standards have also been upgraded over the years, as the population has increased, and the need to insure protection of groundwater quality has become more apparent.

In addition, the inspectional services of the SCDHS investigate public health nuisance complaints to enforce sanitary code regulations regarding failing sewage systems and correct any conditions that may be deleterious to the public health. Many of these public health nuisance complaints arise in areas where soil conditions are poor for sewage leaching. These conditions may include the presence of soil with a high clay content or a high water table, or the existence of older disposal facilities, constructed at a time when standards were less stringent and impaired by long term use that has reduced the leaching capabilities of the systems.

The inspectional services of the SCDHS conducted a survey in August 1984 of twelve homes immediately north of the lake. At that time, most of the homes were using pumps to remove water from the basements, but only one home had a failing sewage disposal system due to flooding. An inspection and dye test of the sewage disposal system for the apartments on the north side of the lake was conducted in August 1985. There was no indication of any malfunction that might impact the lake.

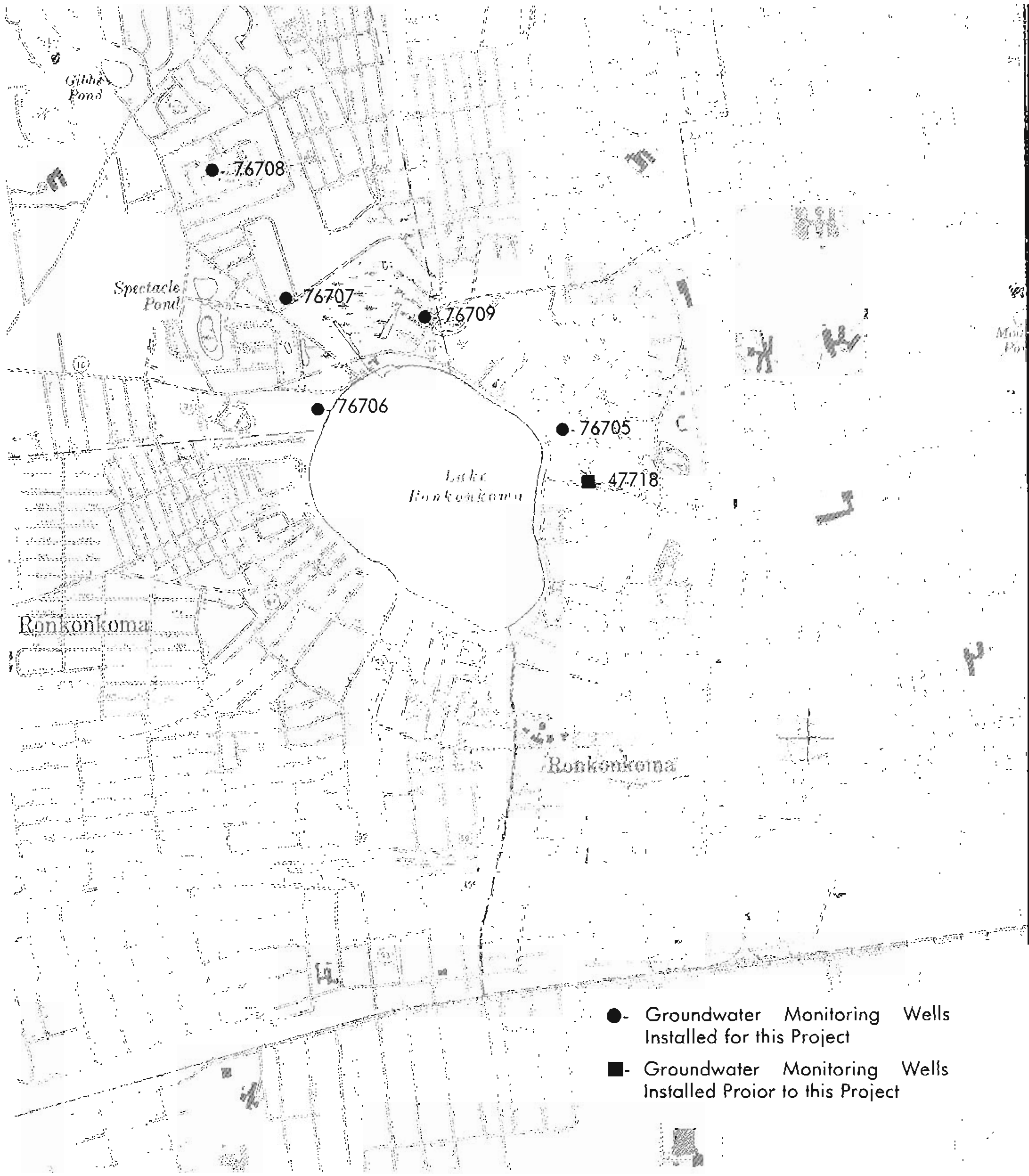


Figure 3-5
WELLS WITHIN the VICINITY of the LAKE

A survey was also conducted in August 1985 of all restaurants and temporary residences on Lake Ronkonkoma. Special attention was given to the sewage disposal systems of the establishments located on the perimeter of the lake. Sewage disposal systems were dye tested to detect any possibility of sewage intrusion in the lake, either directly by overland flow or indirectly by underground seepage. The dye testing indicated all systems were operating in compliance with sanitary code regulations.

3.1.5 United States Geological Survey Monitoring Program[3]. Ongoing monitoring programs by the USGS at Lake Ronkonkoma includes an observation well and a stream gaging station. The observation well, which is located at Shore Road, is used to measure water table levels. Water table levels have been recorded since 1937 to the present. The highest water level measured was 59.20 ft. National Geodetic Vertical Datum (NGVD) on June 6, 1979 and the lowest water table level measured was 50.63 ft. NGVD, December 28, 1966. The Stream gaging station at Lake Ronkonkoma measures the base flow flowing from the bog under Smithtown Boulevard to Lake Ronkonkoma. This stream gaging station is known as a *low flow partial record station*, with an average base flow of 0.55 cfs or approximately 500,000m^3 per year.

3.1.6 Studies of Lake Ronkonkoma.

3.1.6.1 Development of Biofiltration Ponds, Past Monitoring Results, Present Status of Ponds. The following report *Treatment of Non-Point Source Stormwater Pollution in Lake Ronkonkoma by Biological Filtration* (July, 1980) was prepared to address the problem of periodic high bacteria counts that has caused the closure of the town beaches. The study identified stormwater and the large number of bathers as the sources of high bacteria counts. As a result of this finding, the project was designed to treat stormwater runoff by a combination of biological and physical processes to reduce coliform and nutrient loadings to the lake.

The study identified two sites that would be appropriate for the installation of biofiltration ponds to contain runoff from the drainage areas. The ponds were located on opposite sides of the lake in the Towns of Islip and Brookhaven. (See Figure 3-6). Two ponds were installed at approximately five feet in depth, each with an impermeable liner covered with six to twelve inches of clean sand and loam and planted with indigenous aquatic plants.

Each system incorporated a surge tank at the influent pipe to reduce water velocity and heavy suspended solids. A variable weir was utilized to control storage capacity. Indigenous aquatic species were placed in the ponds to remove nutrients and metals by their food uptake. These plants were harvested to remove the contaminants contained in their vegetative structure. The leaching of trapped nutrients and heavy metals to groundwater was prevented by lining the entire basin with a vinyl sheet.

Water quality samples were taken during both dry and wet weather at the influent pipe from the surge tank, at the effluent pipe leading to the overflow chamber and in the lake immediately outside the ponds. Samples for bacteria, nutrients and metals were taken at each location.

The biofiltration ponds were established to minimize pollutant loads normally found in stormwater runoff to the lake. Due to rising water levels in the lake, the Islip pond was severely damaged shortly after installation and continued monitoring of the efficacy of the pond was no longer possible. The Brookhaven Pond sustained significant damage in 1984. During the initial phase of this study, it was determined that the catchment area did not supply a volume of runoff sufficient for monitoring purposes.

These two systems were capable of handling only a small percentage of the stormwater entering the lake. They were established as prototypes in order to determine the potential applicability of this type of system for treating the majority of stormwater runoff entering the lake.

[3]United States Departmnt of Interior; Geological Survey, *Water Resources Data for New York, Water Year 1983, Volume 2, Long Island.* Albany, N.Y.: USGS, July 1984.

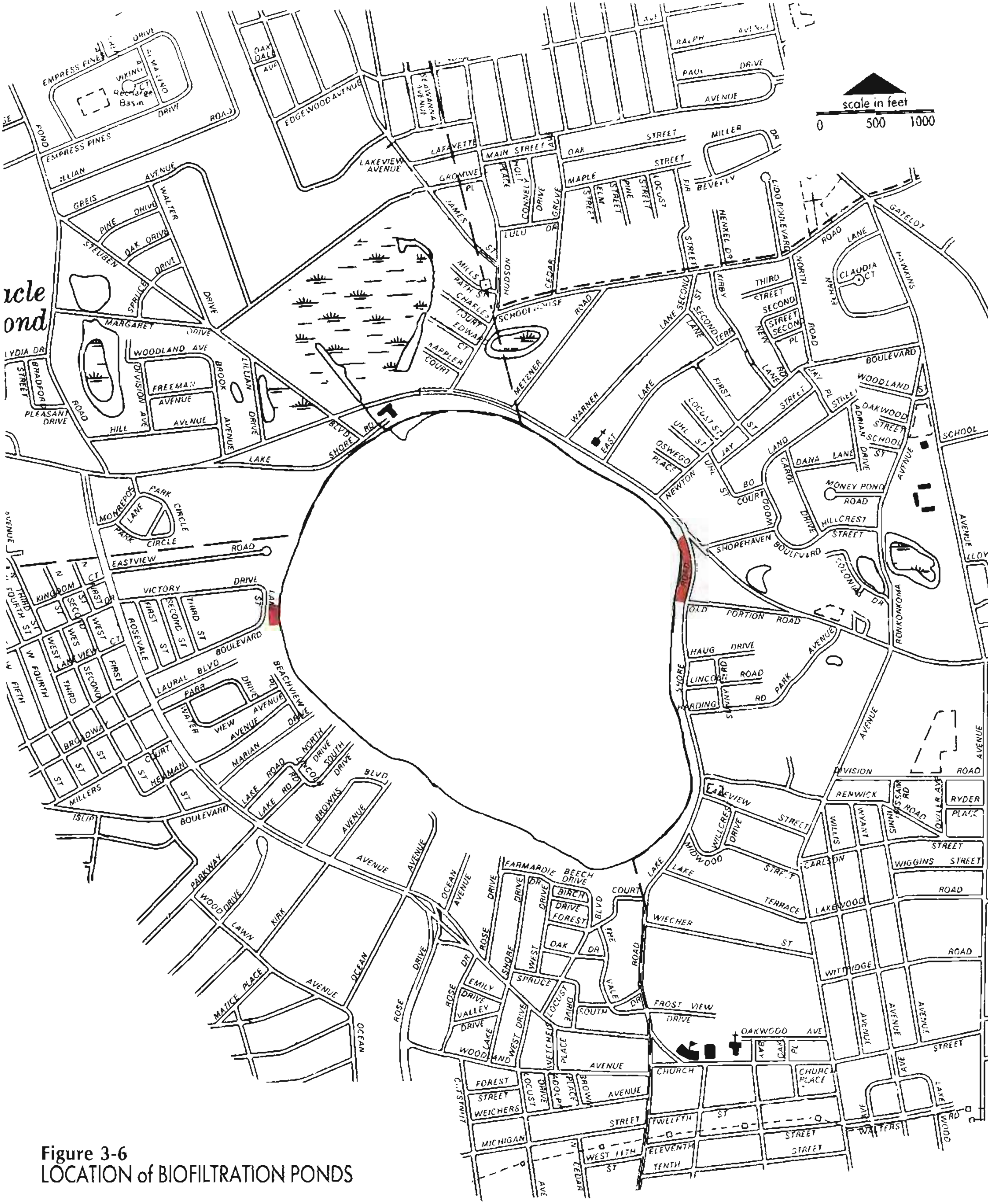


Figure 3-6
LOCATION of BIOFILTRATION PONDS

3.1.6.2 Fertilizer, Pesticide and On-Site System Survey. A fertilizer, pesticide and on-site system survey was conducted in the Autumn of 1983. Prior to the detailed survey, a field survey of several areas plus a review of the available groundwater and stormwater information were evaluated in order to determine which areas would be most appropriate to examine in terms of their probable impact on the lake. Three areas were identified:

- the *groundwater contributory area* located north of the lake, which is most likely to contribute groundwater to the lake due to the fact that the groundwater generally flows from north to south in this area
- the area west of the lake in the vicinity of the Parr Drive and Waterview Drive area, which has a stormwater outlet to the lake
- the southeast catchment area for the lake, where a thirty acre watershed has been delineated.(See Figure 3-7).

A total of eighty-eight homes were surveyed, thirty-five in the groundwater contributory area, twenty seven in the area west of the lake and twenty-six in the southeast catchment area. Residents were asked how many times per year fertilizer and pesticides were applied, and had cesspools failures occurred within the last few years. (See Figure 3-8).

FERTILIZERS

Of the eighty-eight respondents, seventy-three households either fertilized their own lawns or had professionals provide lawn maintenance. Fifteen households did not fertilize their lawns at all. Forty families applied their own fertilizer, while thirty-three families employed professional lawn services. In general, it was found that lawns maintained by professional lawn services were fertilized more frequently (4-5 times/ year) than those lawns that were maintained by the homeowners. (1-2 times/ year).

A study completed by Cornell University in 1977, estimated that fertilizer is applied at a rate of 2 lbs. of nitrogen(**N**) per 1,000 square feet. Most homeowners indicated that they follow the recommended application rates on the bag of fertilizer. This generally agrees with 2.3 pounds **N** per 1,000 square feet[1]. However, professional lawn services generally apply between 1 to 2 pounds **N** per 1,000 square feet per application or at the rate of 4 to 10 pounds per 1,000 square feet per year.

The Cornell Study indicates that the greatest loss of nitrogen applied to lawns occurs when fertilization is followed by irrigation or rainfall. Of the total amount of nitrogen generally applied to lawns some of the nitrogen is carried by stormwater runoff, some is volatilized or taken up by plants and the remainder leaches to groundwater. For average Long Island conditions, it is estimated that approximately sixty percent of the nitrogen applied to turf leaches to groundwater, depending on the occurrence and intensity of rainfall, site conditions and the age of the turf. Immature turf requires more nitrogen than mature turf.

A study was conducted on Long Island in 1973[2] which included a short term survey of thirty five sites which comprised of a variety of grass species, soil types and levels of fertilization. The study concluded that since on Long Island turf roots rarely extend beyond nine inches into the soil, soil nitrogen below nine inches is subject to leaching.

According to this study, phosphorus contained in fertilizer, is readily adsorbed into the soil particles and seldom moves below the first foot of soil. Thus, phosphate pollution is minimized by the soil adsorption process, except when phosphates are transported to surface waters by eroded soil particles.

PESTICIDES

Of the eighty-eight respondents, forty households used pesticides. Sixteen people applied the pesticides themselves, while twenty-four employed professional lawn services. Pesticides are generally applied one to two times per year.

[1]Porter K.S.; Nitrogen on Long Island: Sources and Fate (New York:Cooperative Extension Service, Cornell University, 1977.)

[2]Rykbost, K.A., Long Island Turf Fertility Management Survey - 1973 Manuscript (New York:Department of Vegetable Crops, Cornell University, 1973).

Methods of application included spraying and the use of a spreader for granular materials. These pesticides were used either for lawn maintenance purposes or the maintenance of small gardens. During application, pesticides may be lost in spray drift or by volatilization. Once they are applied, the chemicals may undergo biological or chemical degradation on the foliage or soil surface. Particles which are deposited in the soil layer may be carried off in surface runoff or move down through the soil into the groundwater. However, there are several factors that can affect this process: properties of the pesticide, soil moisture level and type of soil, amount and intensity of precipitation and air temperature.

The residents surveyed indicated use of a variety of pesticides. One of the more frequently used pesticides was *Diazinon*. Although this chemical is poisonous to both humans and animals, it decomposes rapidly on exposed surfaces, usually within two to three days. Another commonly used pesticide was *Sevin*. It is moderately toxic to animals, is short lived and is generally not hazardous if used as directed.

The impacts of the use of these pesticides, in the watershed area, on lake water quality is not known at this time.

3.1.6.3 Animal Waste. In addition to the questions regarding fertilizer and pesticide use, homeowners were asked if they owned any pets. This question referred mainly to the ownership of cats and dogs. Of the eighty-eight respondents, thirty-nine of the households surveyed owned one or more dogs for a total of forty-nine dogs and twenty-two households owned one or more cats for a total of thirty-three cats.

The LIRPB *Long Island Comprehensive Waste Treatment Management Plan - 1976* identified dogs as a major general source of nonpoint source pollution in Nassau and Suffolk Counties. Dog wastes, mainly those deposited on paved surfaces are significant sources of *Biochemical Oxygen Demand* (BOD), fecal coliform and fecal streptococcal bacterial loadings to surface waters. Cats have also been identified as a nonpoint source pollutant. However, due to inadequate records, it is hard to estimate the degree of pollution. In addition the Nationwide Urban Runoff Program identified warmblooded animals such as dogs, cats, rodents and other small animals as the primary contributors of fecal coliform and fecal streptococci bacteria. High bacteria loadings have occasionally been a problem in the past causing the closure of shellfishing areas and beaches to swimmers.

In 1977, the Soil Conservation Service completed a report *Animal Waste Control Alternatives, Nassau and Suffolk Counties, New York* which included animal census information and provided evidence of the impacts of animal wastes on ground and surface waters. The nutrients from animal wastes such as nitrogen and phosphorous can affect the ecology of freshwater systems by disturbing its natural balance. For purposes of the study, it was assumed that fifty percent of the nitrogen in pet waste would be lost in gaseous form. The remainder is deposited on the soil surface, where it may be removed by runoff or subsurface percolation.

3.1.6.4 Holzmacher, McLendon and Murrell (H2M) Study Highlights. The Holzmacher, McLendon and Murrell, P. C. (H2M) Corporation prepared a groundwater relief study as consultants for the Suffolk County Department of Public Works. The study entitled *Drainage Improvements including Groundwater Relief, Phase I - Feasibility study* included evaluation of conditions in the vicinity of the northeast branch of the Nissequogue River and Lake Ronkonkoma. This study comprises three volumes:

- Volume I - *Basic Data and Preliminary Findings*
- Volume II - *Solutions to Flooding in the Vicinity of the Northeast Branch of the Nissequogue River*
- Volume III - *Solutions to Flooding in the Vicinity of Lake Ronkonkoma*

Volume I includes a physical description of the Lake Ronkonkoma area including climate, precipitation, topography, geology, hydrology, soils, lake erosion problems, water levels and the lake water budget. An environmental assessment of current conditions, basic data and

Figure 3-7
FERTILIZER and PESTICIDE STUDY AREA

FERTILIZER AND PESTICIDE SURVEY

(Questionnaire)

1. Address ______________________

2. Section
   a. Groundwater Wedge (north of the Great Marsh) ________
   b. West of Lake (Parr Drive Area) ________
   c. Southeast Catchment Area ________
   d. Eastview Drive ________

3. Land Use
   Residential ____
   Commercial ____
   Institutional ____

4. General Lawn Maintenance
   Low ______ % in turf ______
   Average ____ Old turf ____ New turf ____
   High ______

5. Fertilizer Application
   Approximately how much fertilizer has been applied since January, 1983? ______
   When? ________(Mo.)
   Brand Name and Product ________
   Where do you buy it?________
   What is the rate of application?________
   Do you water right after you fertilize? ________
   If maintained by a professional firm, who?________
   Total Maintenance?________

6. Pesticide Application
   Approximately what quantity of pesticides have been applied since January, 1983?________
   Brand Name and Product?________
   For what type of pests?________
   Method of Application?________Rate?________
   How do you dispose of unused pesticides?________

7. Animal Waste
   Do you have any pets?
   Dog ______(#) Cat/small dog ______(#)

Figure 3-8
SAMPLE QUESTIONAIRE

CONSUMER PRODUCTS SURVEY

Address:
Date:
No. of Years at House: Year House Built:

Cesspools:	Front:	Rear:	Side:
Septic Tank:	Yes:	No:	
Cesspool Failures:	Yes:	No:	
Cesspool Pumped:	Yes:	No:	
Chemical Additives:	Yes:	No:	

Type or Brand Name — Quantity & Years Applied

Do you have a washing machine? Yes: No:
Separate cesspools or drywell? Yes: No:

Brand of Laundry Products Used — Quantity

Have you done any house painting in the last two years? Yes: No:
Inside: Outside:
Type of paint used:

Types of Solvents & Cleaners Used — Quantity

Auto Repairs: Yes: No: Change Oil: Yes: No:

Degreasers & Solvents Used — Quantity

findings is also provided. The pumping of the recharge basins located north of the lake is discussed in conjunction with the precipitation patterns (wet years) which has resulted in flooding problems in areas surrounding the lake. The plan also identifies several areas that had originally contained wetlands that were filled in during a drought period and subsequently developed. When the drought ended and the water table rose to normal or above normal conditions, these areas developed flooding problems.

Possible solutions to flooding are also discussed in general in Volume III (Volume II discusses flooding solutions in the Northeast Branch of the Nissequogue River). Possibilities of transporting water to Long Island Sound or to Great South Bay were discussed. In addition, the feasibility of discharging excess lake water to portions of the Nissequogue River or to the headwaters of the Connetquot River were also evaluated.

However, no specific action has been undertaken as result of the H2M Study. None of the proposals appear to be viable. Transporting water to the headwaters of the Nissequogue or to the Connetquot appear to be undesirable and transportation of water to Long Island Sound or the Great South Bay are extremely costly.

Chapter 4....

Study Sampling Programs and Existing Water Quality

4.1 AMBIENT LAKE QUALITY SURVEY

4.1.1 Introduction. The purpose of the ambient lake quality survey was to measure and document the chemical, physical, and biological characteristics of the lake during periods between storms. Ambient lake quality could then be used as a baseline against which the impact of stormwater runoff would be evaluated.

4.1.1.1 Location and Depth of Sampling Sites. Five lake sampling stations, LR-1 through LR-5, were established, at locations in the lake that might possibly exhibit differences in quality due to influence from the shore (e.g. storm drains, bog stream,motel, biofiltration pond, etc.) See Figure 4-1. Station LR-1 was located over the deepest area in the lake (20-22 meters), LR-2 was offshore from the Brookhaven biofiltration pond, and LR-3 was proximate to the Great Bog Stream inflow and offshore from a motel on the northeast shoreline. LR-4 was slightly north of the Islip biofiltration pond near a storm drain on the northwest shore. LR-5 was offshore from the Islip bathing beach. Each lake station, excluding LR-1, was 3-4 meters deep. The sixth sampling station, LR-6, was in the stream that flows south through a culvert from the bog and mixes with the lake water at the point where the samples were collected.

Five lake sampling stations were used to detect horizontal spatial differences in water quality due to the proximity to the shore of various contaminant sources such as commercial installations, runoff drains, and natural drainage. At each station, water quality stratification was monitored to obtain profiles of dissolved oxygen concentrations and temperature at 1-meter intervals on all sampling dates. Water chemistry samples from the 1-meter and 3-meter depths, (LR-2 through LR-5), and from the 1-meter and 15-meter depths were utilized to determine vertical water quality differences and plant nutrient concentrations (See Table 4-1).

4.1.1.2 Event Schedule. Ambient lake quality monitoring was conducted during dry weather on a monthly schedule from December through April, and bi-weekly from May through November when weather conditions permitted (Table 4-1).

An extensive bathymetric survey was completed on May 24, 1984. (See Figure 4-1).

4.1.2 Methodology.

4.1.2.1 Equipment and Collection Procedures. Water chemistry samples were taken at the appropriate depths with a Van Dorn water sampler, delivered to thrice rinsed four-liter bottles and held in the shade. Whole water samples were split, or appropriately filtered, within 30 minutes of the last sample collection at the New York State Department of Environmental Conservation Ridge facility. Sample bottles (125 ml) were rinsed three times with sample water, filled to overflowing with whole water and filitered through a .045 micrometer (μm) filter, and tightly capped. Samples were then delivered to Suffolk County Department of Health Services (SCDHS) Laboratory, within 3-4 hours of collection, for water chemistry analyses.

Field measurements were used for pH and alkalinity. Alkalinity and pH were determined as soon as the water chemistry samples had been distributed to sample bottles (Table 4-2). Specific conductance was measured upon delivery of samples to the laboratory.

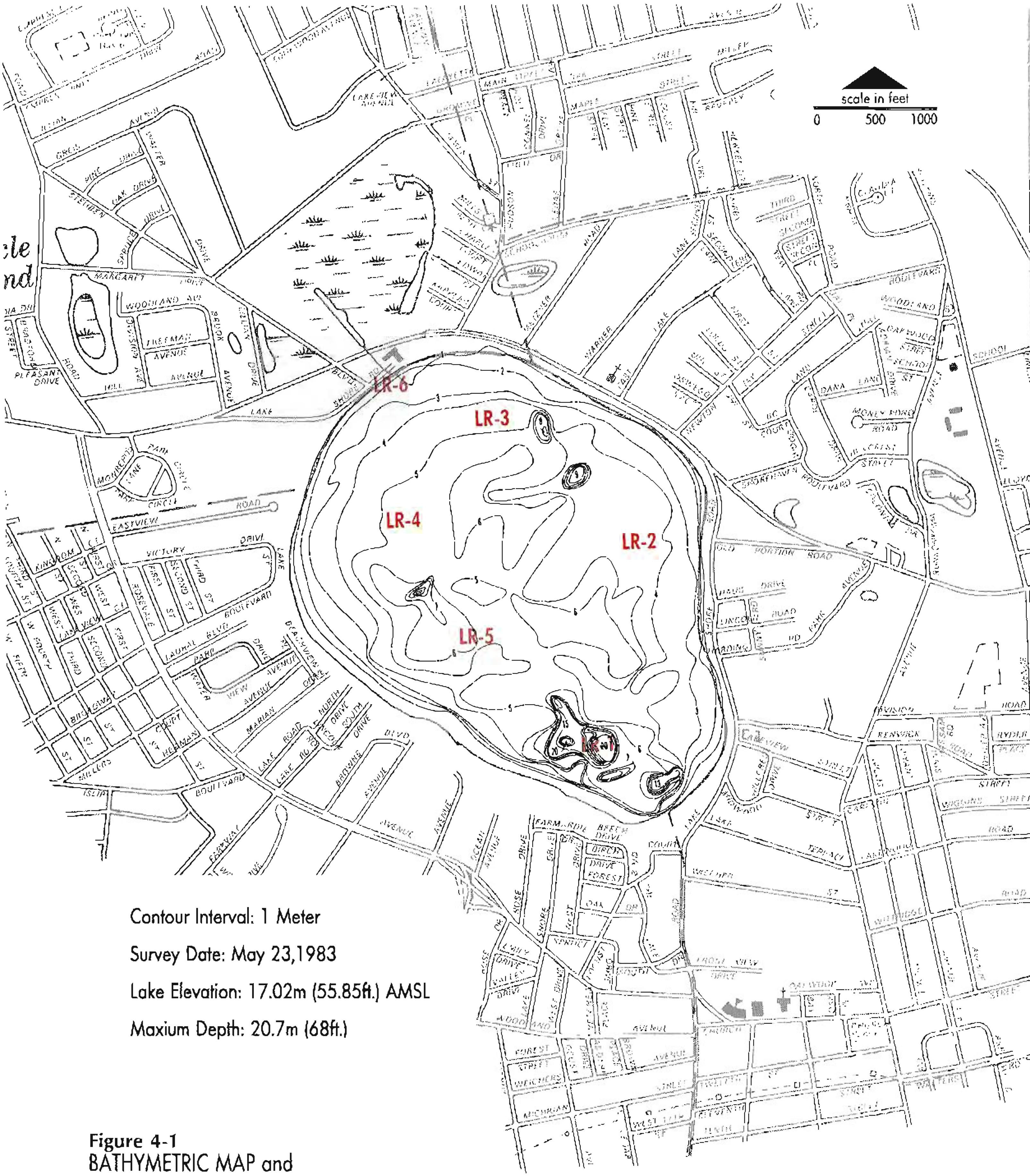
Phytoplankton samples were poured from the 1 meter depth lake sample at LR-1 into a clean (acid washed) 125 ml bottle containing 3-5 ml of Lugol's solution(I_2KI). Chlorophyll *a* samples were filtered onto $MgCO_3$ treated 0.45 μm Millipore filters and kept on ice in capped centrifuge tubes in the dark for analysis the following day. Zooplankton samples were preserved in 4% formalyn and analyzed at a later date. Samples for bacteria analyses were poured into sterile sample bottles, tightly capped and delivered to the SCDHS Bacteriology Laboratory within 3-4 hours of collection.

4.1.2.2 Analytical Methods. Standard water chemistry analyses were performed by Suffolk County Department of Health Services (SCDHS) (Table 4-3). Bacteriological samples, taken from May through August, 1983, were also analyzed by SCDHS (Table 4-2).

Table 4-1
Sampling Schedule, Ambient Lake Quality Survey
(November 1982 through May 1984)

SAMPLING DATE	LAKE STATION SAMPLED	DEPTH of SAMPLE (meters)	TYPE of SAMPLE*
11-9-82	LR-1	1,12,18	A,B,C,D,G,H,I,J
	LR-2,3,4,5	1	A,B,C,D,G,H
	LR-6	Subsurface	A,B,C,F,G,H
1-6-83	LR-1	1,19	A,B,C,D,G,H.I.J
	LR-6	Subsurface	A,B,C,E,G,H
2-15-83	LR-1	1,5	A,B,C,G,H
	LR-6	Subsurface	A,B,C,F,G,H
3-16-83	LR-1	1,18	A,B,C,D,G,H.I.J
	LR-2,3,4,5	1	A,B,C,D,G,H
	LR-6	Subsurface	A,B,C,F,G,H
5-10-83	LR-1	1,15	A,B,C,D,G,H.I.J
	LR-2,3,4,5	1	A,B,C,D,G,H
	LR-6	Subsurface	A,B,C,F,G,H
5-24-83	LR-1	1,15	A,B,C,D,G,H.I.J
	LR-2,3,4,5	1,3	A,B,C,D,G,H
	LR-6	Subsurface	A,B,C,F,G,H
6-14-83	LR-1	1,15	A,B,C,D,E,G,H.I.J
6-28-83	LR-2,3,4,5	1,3	A,B,C,D,E,G,H
	LR-6	Subsurface	A,B,C,E,F,G,H
	Brookhaven & Islip Beaches	Subsurface	A,B,C,E,G,H
7-19-83	LR-1	1,15	A,B,C,D,E,G,H.I.J
	LR-2,3,4,5	1	A,B,C,D,E,G,H
	LR-6	Subsurface	A,B,C,E,F,G,H
	Brookhaven & Islip Beaches	Subsurface	A,B,C,E,G,H
8-2-83	LR-1	1,15	A,B,C,D,E,G,H.I.J
8-16-83	LR-2,3,4,5	1	A,B,C,D,E,G,H
8-30-83	LR-6	Subsurface	A,B,C,E,F,G,H
	Brookhaven & Islip Beaches	Subsurface	A,B,C,E,G,H
9-27-83	LR-1	1,15	A,B,C,D,G,H.I.J
11-1-83	LR-2,3,4,5	1	A,B,C,D,G,H
	LR-6	Subsurface	A,B,C,F,G,H
11-20-83	LR-3	1	A,B,C,D,G,H
	LR-6	Subsurface	A,B,C,F,G,H
12-20-83	LR-1	1,15	A,B,C,D,G,H.I.J
3-20-84	LR-2,3,4,5	1	A,B,C,D,G,H
4-10-84			
5-7-84	LR-6	Subsurface	A,B,C,F,G,H

* Code:
A - Alkalinity, pH, conductance
B - Dissolved Oxygen, temperature
C - Chlorophyll *a* concentration
D - Secchi depth
E - Total coliform, fecal coliform
F - Total carbon
G - Total phosphorus, dissolved phosphorus
H - NO_3, NO_2, NH_3, Total K-N, Dissolved K-N
I - Zooplankton tow
J - Phytoplankton (1m)



Contour Interval: 1 Meter

Survey Date: May 23,1983

Lake Elevation: 17.02m (55.85ft.) AMSL

Maxium Depth: 20.7m (68ft.)

Figure 4-1
BATHYMETRIC MAP and
SAMPLING STATIONS

Table 4-2
Analytical Procedures Utilized for Field Measurements and Biological Analyses

PARAMETER	METHOD	REFERENCE
pH	Electrometric, combination electrode	EPA (1979), Method 150.1
Alkalinity	Titrimetric, pH 4.5, sulfuric acid	EPA (1979), Method 370.1
Conductance	Specific conductance,µmhos as 25°C, self-contained conductivity meter, wheat-stone bridge type	EPA (1979), Method 120.0
Dissolved Oxygen	Membrane electrode, membrane covered polarographic sensor	EPA (1979), Method 360.1
Temperature	Thermometric	EPA (1979), Method 170.1
Chlorophyll **a**	Fluorometric method	Standard Methods, Pg. 7031 Method 1002 G.2
Zooplankton	Wide mouthed pipette, open chamber binocular dissecting microscope	Edmondson & Winberg, 1971
Phytoplankton	Sedimentation & inverted microscope	Uturmöl, 1958; Vollendweider, 1969
Coliforms (fecal)	MPN procedure	Std. Methods, Method 908C
Coliforms (total)	MPN procedure	Std. Methods, Method 908A
Fecal Streptococci	Membrane filter procedure	Std. Methods, Method 910B

Phytoplankton samples were analyzed on an Olympus inverted compound microscope at 100x magnification (Utermohl 1958, Vollenweider 1969, Lund et al separate 5 mL subsamples taken from a field tow brought to 500 mL (Edmondson and Winberg, 1971). Subsamples were taken with a Hensen Stemple-pipette, and held in an open stratified dish for enumeration under 60 x magnification on a Bausch & Lomb Binocular dissecting microscope. Organisms were identified to species at 100x magnification on an Olympus inverted compound microscope. Species were identified according to Brooks 1957, Ward & Wipple 1965, and Pennak 1978.

Chlorophyll **a** was extracted with 90% acetone and analyzed by fluorometry using a Turner fluorometer with primary and secondary filters at 430 and 650 µm, respectively. Pheophyton was determined in the second set of fluorometric readings, after the samples had been acidified with 100 µL of 1N HC1 (V/V) in distilled water.

4.1.3. Results

4.1.3.1 In-lake Spatial Variation (Point In Time Characterization). Lake Ronkonkoma proved to be a homogeneous mass of water from surface to bottom, with the exception of the small percentage of water volume contained in the two deeper holes (Figure 4-1). Approximately 95% of the lake water volume (≤ 6 meters deep) was continuously well mixed during the study period. Depth profile measurements of temperature at LR-1 revealed that thermal stratification did not occur above the 6 meter depth contour. A *thermocline* was in place below the 6 meter depth contour by May and persisted through September. Samples taken near the bottom at LR-2 through LR-5 showed vertical homogeneity among physical, chemical, and biological (chlorphyll **a**) parameters (See Appendix A and B).

Table 4-3

Analytical Procedures for Water Quality Analyses
Ambient Lake Quality Survey,

PARAMETER	ANALYTICAL PROCEDURE REFERENCE
NO_3 & NO_2	Technicon Autoanalyzer II Method (Cu/Cd Reduction, Dizotized, Sulfanilamide, coupled with napthy lethylene Diamine Dihydrochloride)
NH_3	EPA Method 353.2 (Colorimetric, Automated, Cadmium Reduction)
TKN and DKN	EPA Method 351.1 (Colorimetric Semi-Automated Phenate). Modified Sulfuric Persulfate Digestion to convert to Ammonia.
Total Phosphate	EPA Method 365.1 (Colorimetric, Semi-Automated Ascorbic Acid) Modified Sulfuric-Persulfate Digestion to convert to Orthophosphate
Dissolved Phosphate Ortho-phosphate	EPA Method 365.2 (Colorimetric, Ascorbic Acid)
TOC	EPA Method 415.1 (Combustion or Oxidation)

Spatial uniformity was further confirmed by between-station comparison of water chemistry results for any one sampling date. Although there was some variability among sampling stations in respect to chemical parameters, systematic and predictable spatial differences were not found. The least between-station variability on any single sampling date was noted for nitrogen compounds. (See Appendix A - Table 1) The smallest observed variation among phosphorus measurements for any single sampling date was within the limits of analytical precision determined by QA replicate/duplicate analyses (See Appendix A - Table 1). Temperature, dissolved oxygen, alkalinity, specific conductance and pH measurements among sampling stations also indicated the homogeneous nature of the water volume above the 6 meter depth contour(See Appendix B-Part 2 Table 1).

4.1.3.2 In-Lake Temporal Variation.

4.1.3.2.1 Physical Characteristics of the Water Column. Lake Ronkonkoma, including the deep holes, is a warm water lake that has two seasonal overturns. These periods of free circulation usually occur in the spring and fall. During the sampling period, the water column was isothermal (equal temperature) at 4°C throughout January and most of February. Spring turnover occurred in March, followed by summer stratification and fall turnover by November. Three inches of ice covered the entire lake surface during February, and near-surface water temperatures fell below 4°C to a depth of about 4 meters. Surface water temperature warmed to 10°C by the end of April, reaching 27°C by mid-July, and cooling to 10°C by November (See Figure 4-2).

The lake volume above the 6 meter depth contour is *polymictic* in the sense that, at any point in time, the water column can be *isothermal* due to mixing. Excluding the deep hole volumes, the entire lake volume becomes an *epilimnion*, persisting throughout the summer growing season. The mixed layer maintains a temperature range ideal for algal growth (20-25°C) from the beginning of June through the end of September.

Water clarity, as measured with a Secchi disk, was very poor during the summer of 1983. Secchi depths ranged from 1.8 meters to 0.55 meters with a summer average of about 1.0 meters. Low water transparency appeared to be a function of phytoplankton abundance. The water color was green to blue-green on all summer sampling dates. Turbidity due to suspended silt, giving a muddy or brownish color to the water, was not observed.

4.1.3.2.2 Chemical Characteristics of the Water Column.

4.1.3.2.2.1 Alkalinity, Conductivity, pH. The waters of Lake Ronkonkoma are low in buffering capacity (i.e. alkalinity), moderate and stable with respect to conductivity, and are generally circum-neutral and generally stable with respect to pH (ie. pH values ranging from 6 to 7). Lake Ronkonkoma water character is not unlike that of other Long Island lakes which receive a portion of their inflow from groundwater in the Upper Glacial Aquifer (e.g. Jones and Wood, 1983).The alkalinity of water is its acid-neutralizing capacity, or the sum of all titratable bases(APHA, 1985) expressed as mg calcium carbonate ($CaCO_3$)/l. Low alkalinity is a common characteristic of lakes with weakly soluble minerals in the drainage basin (e.g. siliceous compounds). Alkalinity in Lake Ronkonkoma surface waters ranged from 10 mg $CaCO_3$ to 22 mg $CaCO_3$, and did not vary dramatically between sampling dates (See Figure 4-3 and Appendix Table B-2.1).

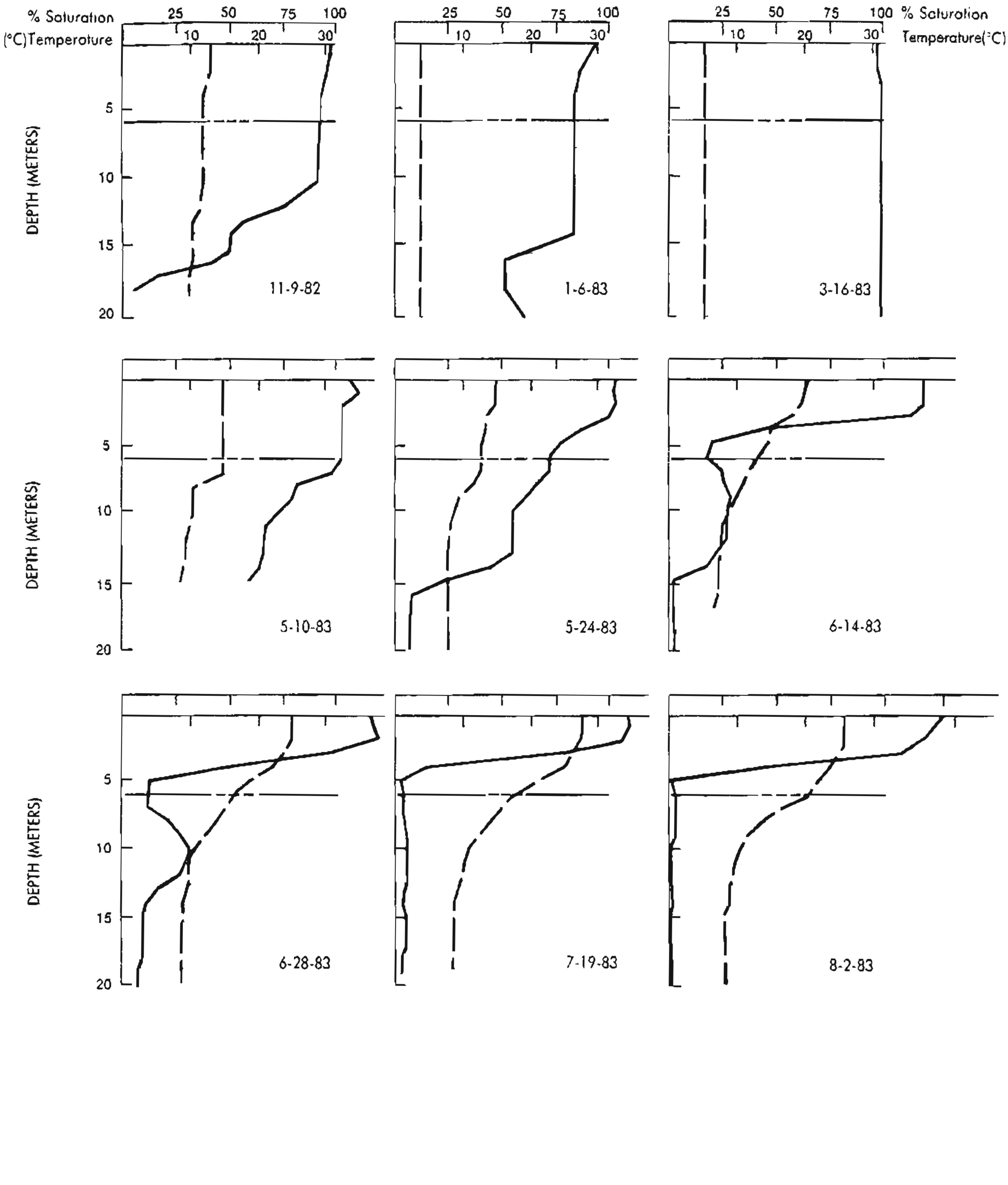
Conductivity is a numerical expression of the ability of an aqueous solution to carry an electric current. Its measurement is often used as an indicator of pulse pollution, since it reflects the relative proportions of ionized and non-ionized substances. For example, the introduction of chlorides untreated domestic sewage or road salt runoff into the lake would be reflected in an increase conductivity. There was a small magnitude temporal variation in conductivity of the Lake ranging from 115 μmhos/cm in May to 160 μmhos/cm in June (see Figure 4-3).

The pH of Lake Ronkonkoma waters indicates at least two important characteristics of the lake. First, the stable circum-neutral pH during most of the year suggests that water does seep to the groundwater system. (See Figure 4-3). If water were not flowing out of the basin, all water loss would be due to evaporation. This would result in the concentration of alkaline substances and a consequent elevation of the pH (Reid & Wood, 1976). Second, the dramatic pH changes that did occur from June through August reflect and confirm the considerable photosynthetic productivity of the waters. Although the pH remained between 6 and 7 throughout most of the year, values greater than 9 were routinely measured during the summer months.

4.1.3.2.2.2 Oxygen Concentration. The two sources of oxygen in lake water are the atmosphere, and photosynthetic activity. Atmospheric oxygen is transported across the air-water interface into the lake. This transport process is enhanced by increased wave action. Oxygen is also a byproduct of photosynthesis performed by the phytoplankton and rooted vegetation during daylight hours. The dissolved oxygen concentration in lake water is an indicator of general lake conditions and plays a role in regulating the metabolic processes of the lake organisms and communities.

Oxygen is also consumed from the lake waters by respiration of all aerobic organisms living within the lake. The metabolism of decomposer organisms can cause oxygen depletion to occur at a depth below the *epilimnion* or mixed zone. As the phytoplankton in the epilimnion synthesize organic material, some of that material sinks and provides sustenance for the decomposers. The decomposers in turn, multiply and consume more of the oxygen stored in the hypolimnion or non-mixed water layer. If oxygen concentrations become too depleted before vertical mixing occurs, typical aerobic communities can be replaced by anaerobic communities and by other aerobic communities that can adapt to low oxygen conditions. (Certain organisms that have iron containing respiratory pigments (hemogloblin) can adapt to lower oxygen conditions.) Continual lake-wide oxygen depletion at depth could cause a shift in bottom invertebrate communities, resulting in a further loss of preferred food organisms for fish species that regularly inhabit the lower water layer.

Dissolved oxygen concentrations and water temperatures measured at Station LR-6 are indicated in Figure 4-9. Oxygen profiles measured at LR-1 in Lake Ronkonkoma (See Figure 4-2) indicate the response of the decomposer community living in the thermally stratified water column due to the considerable primary production in the surface water. By mid-July, the waters


% Saturation
(°C)Temperature
25 50 75 100
10 20 30
% Saturation
Temperature(°C)
DEPTH (METERS)
5
10
15
20
11-9-82
1-6-83
3-16-83
5-10-83
5-24-83
6-14-83
6-28-83
7-19-83
8-2-83

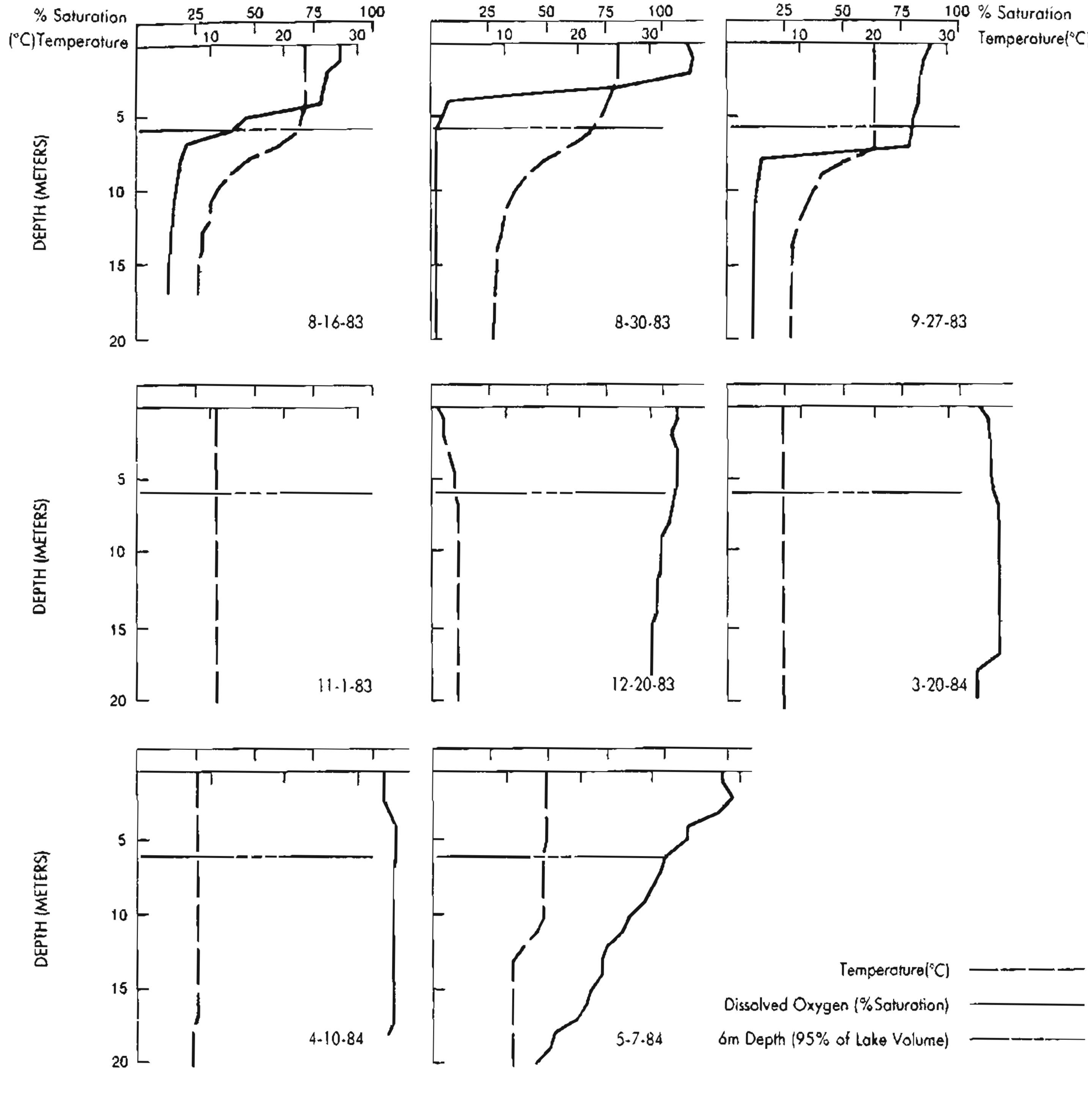


Figure 4-2 *Water Column Temperature and Dissolved Oxygen Concentration (% saturation) at LR-1, November 1982 through May 1984.*

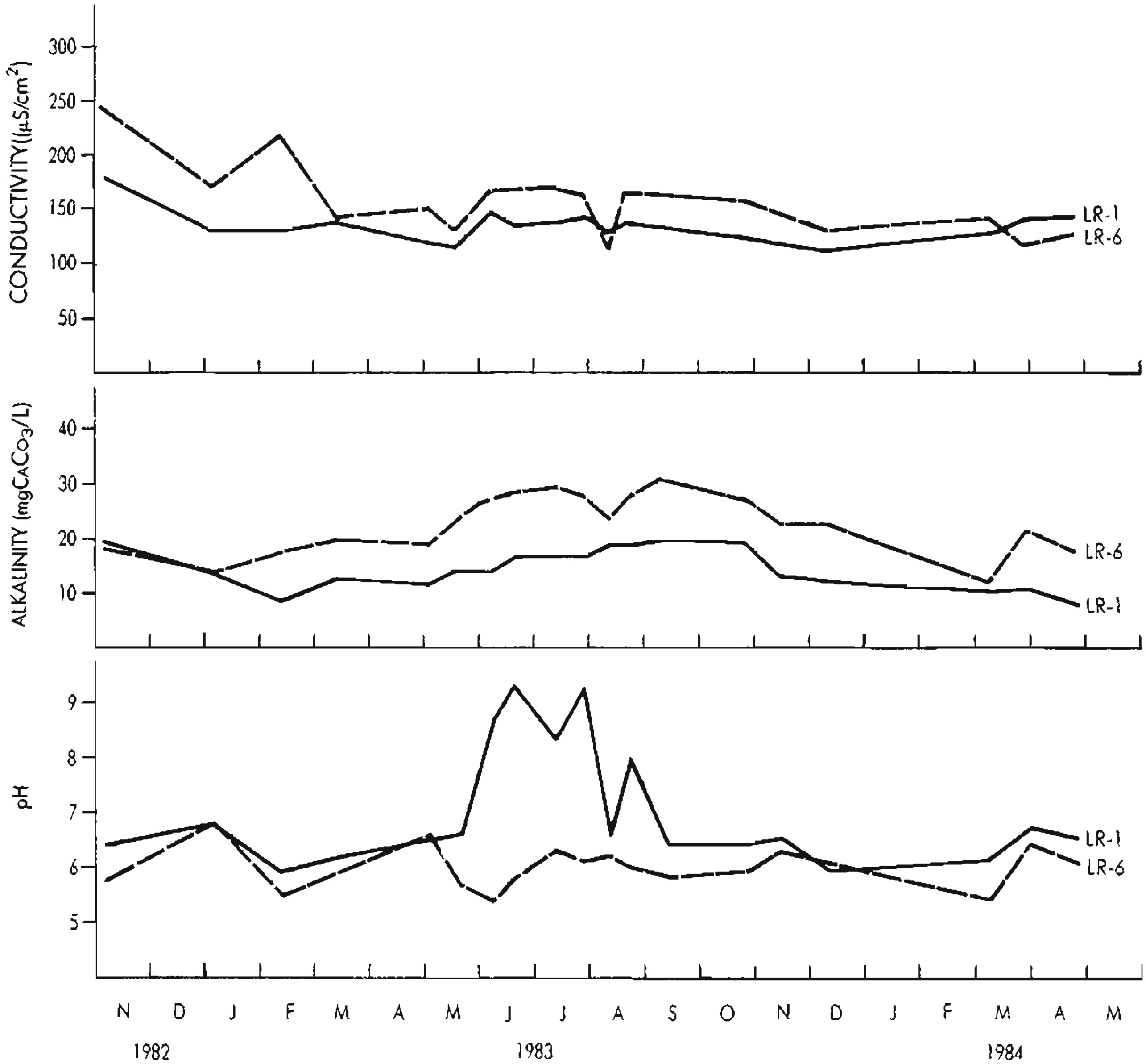


Figure 4-3 *Conductivity, Alkalinity, and pH of Lake Water, (LR-1, LR-6): November 1982 through May 1984.*

below the 5-meter depth were oxygen depleted, and remained in that condition until fall circulation. The waters above the 3-meter depth were oxygen saturated-to-supersaturated from May through the beginning of September, also reflecting the magnitude of primary production. It should be noted that some downward transport of oxygen did occur during thermal statification. The most severe oxygen depletion in the hypolimnion occurred on August 2, and August 30. Between those two dates, on August 16, oxygen saturation at thermocline increased to about 15%, indicating that some mixing had occurred across the thermocline. (See Figure 4-2).

Oxygen profiles were measured during the morning hours between 8 and 9 A.M. These profiles measured during the growing season probably represents the near-lowest daily oxygen concentration of each depth. Depletion of oxygen occurs due to respiration of lake organisms, while at the same time, the lake is not being reoxygenated by photosynthesis that occurs during daylight hours.

Temperature profiles indicate that the epilmnion extends to the lake bottom in over 90 percent of the lake surface area which means the lake mixes from top-to-bottom over the same area.

4.1.3.2.3 Plant Nutrients - Nitrogen and Phosphorus. Nitrogen and phosphorus (together with carbon and hydrogen) are the raw materials required in abundance for synthesis of organic matter. Green plants, such as the *phytoplankton* which constitute the foundation of the entire lake food web, utilize nitrogen and phosphorus in the presence of sunlight to produce *biomass*. The potential accrual of phytoplankton biomass, under favorable temperature and light conditions, depends upon the quantities and proportions of usable plant nutrients present in the lake water at any one time during the growing season. Consequently, nitrogen and phosphorus are most often examined for possible control in seeking to restrict phytoplankton production in nutrient enriched lakes.

4.1.3.2.3.1 Nitrogen. The forms of nitrogen of primary interest in freshwater lakes occurs in various inorganic and organic compounds. Inorganic nitrogen is partitioned among Nitrate (NO_3-), Nitrite (NO_2-), Ammonia (NH_3), and Ammonium (NH_4 –). Ammonia, the first inorganic nitrogen product of organic decomposition, is the most available nitrogen form assimilated by phytoplankton. Nitrate, the oxidative product of ammonia in an oxygenated environment, is also utilized by the phytoplankton. Together, ammonia and nitrate provide the nitrogen sustenance for autotrophic synthesis except under nitrogen limiting conditions when N_2 may become the major source of nitrogen. Nitrite and ammonium constitute a very small, rapidly cycled fraction of the inorganic nitrogen abundance at any one time, especially in a productive, poorly buffered lake (Brezonik, 1973) such as Lake Ronkonkoma.

The organic nitrogen, particulate and dissolved, is represented in the TK-N (Total Kjeldahl Nitrogen) determination. The dissolved fraction (DK-N) is determined in an additional independent analysis. Finally, particulate organic nitrogen is calculated as (TK-N) minus (DK-N plus NH_3-N). The organic nitrogen constituents in lake water reflect the magnitude of nitrogen present in the dissolved and particulate phases of organic matter.

The most important features of the inorganic (bio-available) nitrogen temporal patterns in Lake Ronkonkoma during 1983 were:

- a moderate-to-low annual mean concentration by comparison with other selected northern temperate lakes
- the depletion of nitrate and ammonia in the epilimnion during the growing season (June through September), with the exception of the mid-August increase in ammonia concentration following a phytoplankton bloom collapse.

The magnitude of nitrate and ammonia concentrations over a 12 month period was not unusually high (see Figure 4-4). Nitrate concentrations (in the epilimnion) averaged 0.20 mg-N/l (range <0.02-0.38 mg-N/l) annually, and <0.06 mg-N/l (range <0.02-0.23 mg-N/l) during the growing season. For comparison, nitrate concentrations in Belmont Lake, Long Island (Jones and Wood, 1983) ranged between 1.5 and 3.0 mg-N/l, and ammonia concentrations varied between 0.8 and 3.0 mg-N/l. Stewart and Markello (1974) measured annual nitrate concentrations in six western New York lakes which spanned a small and shallow to large and deep morphometry spectrum. Mean annual nitrate concentrations were reported as 0.5, 0.25, 0.30, 1.25, 0.40, and 0.50 mg-N/l. Reid & Wood (1976), give a general mean nitrate-N concentration in unpolluted freshwater of 0.30 mg-N/l, which is higher than that measured in Lake Ronkonkoma.

Nitrate and ammonia concentrations varied seasonally in a pattern expected for productive lakes (Wetzel, 1974; Hutchinson, 1967). Nitrate concentration was greatest in the epilimnion from December through May (Figure 4-4), falling below analytical detection limits over the June through September period as the phytoplankton depleted the ambient supply. Ammonia concentration followed a similar temporal pattern, with the exception of increased concentrations beginning during late summer and continuing through the autumn. The increased ammonia concentrations can be accounted for by a predominance of organic decomposition over production of the failing phytoplankton standing crop as water temperature cooled and light intensity/duration declined.

The organic nitrogen content in Lake Ronkonkoma was relatively uniform throughout the year, excluding an early-August and late-September peak in TKN concentration (1.2 mg-TKN/l and 1.4 mg-TKN/l, respectively). The annual mean TKN concentration differed from the growing season mean concentration by only 5% (0.04 mg-TKN/l). The early-August TKN peak corresponded to a blue-green algal bloom, when the particulate fraction of organic nitrogen reached an annual high concentration (0.54 mg particulate-N/l). The dissolved fraction of organic nitrogen (DKN) remained relatively constant throughout the year (annual mean-0.60 mg-DKN/l, range-0.3-1.0 mg-DKN/l) reaching the greatest concentration in late-September (1.0 mg-DKN/l) as the summer phytoplankton abundance declined.

4.1.3.2.3.2 Phosphorus. Phosphorus in lake water can be partitioned into two general physical groups, dissolved phosphorus (DP) and particulate phosphorus (PP). The dissolved fraction is composed primarily of $H_2PO_4^{-2}$ and HPO_4^{-2}, the forms of phosphorus that are directly available for phytoplankton up-take. Condensed phosphorus and organic phosphorus make cup a small portion of the dissolved fraction and are rapidly converted to the directly available forms of phosphate (Sonzogni, et. al., 1982). In general, it is the rate of supply and quantity of DP within the euphotic zone that determines the relative status of phosphorus availability and potential growth limitation in the phytoplankton.

The *particulate phosphorus* (PP) comprises mineral compounds and organic particles. The mineral phosphorus can be adsorbed to other inorganic particles, or contained within the physical matrix of particles. Adsorbed phosphorus mineral compounds may become available through dissolution or desorption. Organic particles containing bound phosphorus can be converted to DP through biological mineralization.

Total phosphorus (TP), referred to herein, was determined by an independent analytical method and is the sum of DP and PP.

The concentration of bioavailable phosphorus in the open water of north temperate dimictic lakes exhibits a generally predictable pattern. Under winter ice, a large part of the phosphorus that entered the lake during the previous ice-free period has either biogenically precipitated, or sedimented in association with particles. At ice-out, when the water column becomes isothermal and the hypolimnetic waters are brought to the surface, the phosphorus which had accummulated in the lower waters is distributed throughout the lake. At the same time, the next year's charge of phosphorus enters the lake in snow melt runoff, and spring rain runoff. By the end of spring, this hypothetical lake should contain the highest phosphorus concentrations to be found in the epilimnion until autumnal turnover, when the bottom waters are again mixed upward.

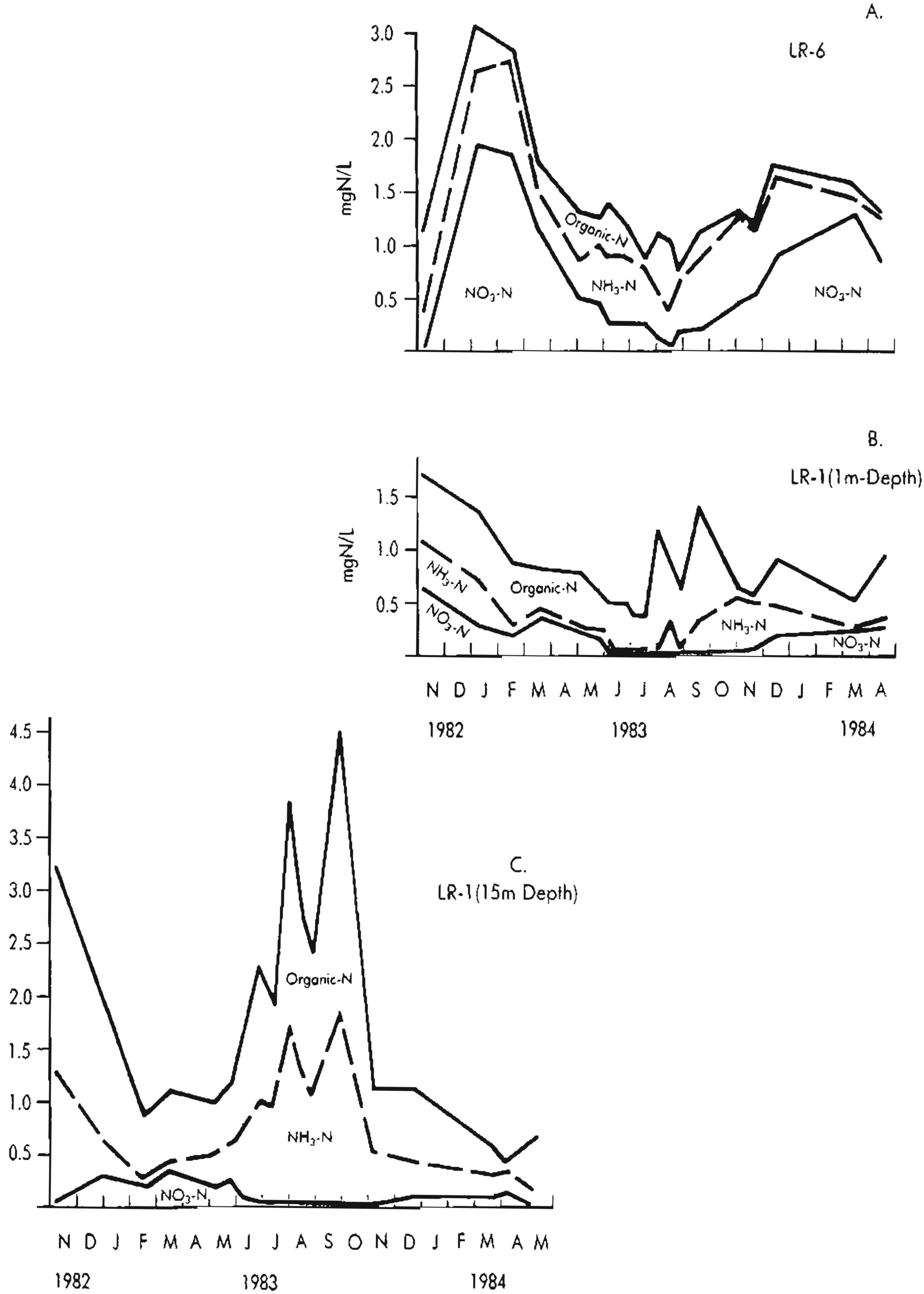


Figure 4-4 *Organic-N, Ammonia-N, and Nitrate-N, (LR-1, LR-6): November 1982 through May 1984.*

Following the spring peak in phosphorus concentration, bioavailable phosphorus may be periodically supplemented with overland runoff and wetfall, but for the most part, would be assimiliated by the phytoplankton, organically bound, and eventually sedimented out of the surface waters. If the watershed does not contain elevated levels of soluble phosphorus that could enter the lake via runoff, the bioavailable phosphorus in the epilimnion should become depleted during the growing season, resulting in limitation of phytoplankton growth.

The *temporal pattern* and *quantities of phosphorus* in Lake Ronkonkoma were somewhat different from those expected for a north temperate dimictic lake. The important characteristics of phosphorus concentration in the epilimnion were as follows:

- although the annual patterns of TP and DP exhibited a bimodal distribution (Figure 4-5) with vernal and autumnal peaks in concentration, the summer supply was never depleted
- DP concentrations were not unusually high, but did remain nearly constant in magnitude and accounted for a large proportion of TP.

The *epilimnetic concentrations* of TP and DP during the growing season suggested continual replenishment. The annual and growing season mean TP concentrations were identical (0.026 mg-TP/l), as were mean DP concentrations (0.010 mg-DP/l). Vernal and autumnal peaks in TP concentration (0.032 and 0.037 mg-TP/l, respectively) were about one-third higher than annual or growing season mean concentrations and represent, in part, an upwelling of TP which has sedimented from the epilimnion during the previous period of thermal stratification. However, the trough area between peaks in the temporal pattern was of greatest interest. In spite of a continued elevated phytoplankton standing crop with favorable growth conditions (i.e. temperature and light), the supply of DP in the water column did not decrease over the summer. Mean DP concentration at the beginning of the growing season (May) was lower than during August and September. The DP that apparently fueled the green algal (chlorophyta) bloom during June should have precipitated resulting in the depletion of epilimnetic DP concentration. Instead, by late July it was replenished in even greater quantity. As the growing season progressed, TP and DP concentrations were continually restored. Additional *allochthonous* phosphorus was entering the euphotic zone repeatedly, (probably from precipitation and stormwater runoff). Apparently phosphorus which had sedimented to the lower waters or lake bottom was frequently reintroduced to the *euphotic zone* during the summer along with contributions of phosphorus associated with precipitation and stormwater runoff.

The high proportion and constancy in magnitude of DP throughout the summer also suggests a continuous renewal of phosphorus. DP averaged 39% of TP annually, and 38% of TP over the growing season (range: 25% to 48%). Unpolluted natural waters commonly contain 10% or less DP in concentration (APHA, 1985; Reid and Wood, 1974; Wetzel, 1974) as a percentage of TP. Certainly, stormwater runoff contributes *pulses* to the DP magnitude and proportion. (See P-Loading breakdown Chapter 5). In addition, mid-to-late summer lake conditions were favorable (See Fig. 4-7) for internal recycling of TP and DP through sediment release, and the combination of shallow morphometry, low relief watershed topography, bather disturbance and climate (i.e. wind frequency, duration, intensity) allows for resuspension of bottom materials by wind induced mixing.

4.1.3.2.3.3 The Nitrogen Phosphorus Ratio (N/P Ratio). An N/P ratio near or below 12 indicates that nitrogen is supplied in smaller quantities than required for growth of most phytoplankton, if the available phosphorus in the environment is to be utilized. An N/P ratio of less than 12 indicates nitrogen limitation to growth except for nitrogen fixing species such as *Anabaena*.

The water column N/P (molar) ratio in Lake Ronkonkoma (Figure 4-6, bottom) indicated nitrogen limitation from early June through the middle of August. The appearance of Anabaena in the lake coincides with the period of dissolved nitrogen depletion and a low N/P ratio. The mid-August N/P ratio was between 0 and 100, probably due to the decomposition of an algal bloom with resultant production of ammonia. By late August, however, the available nitrogen had been assimilated and the N/P ratio returned to a value of about 5.

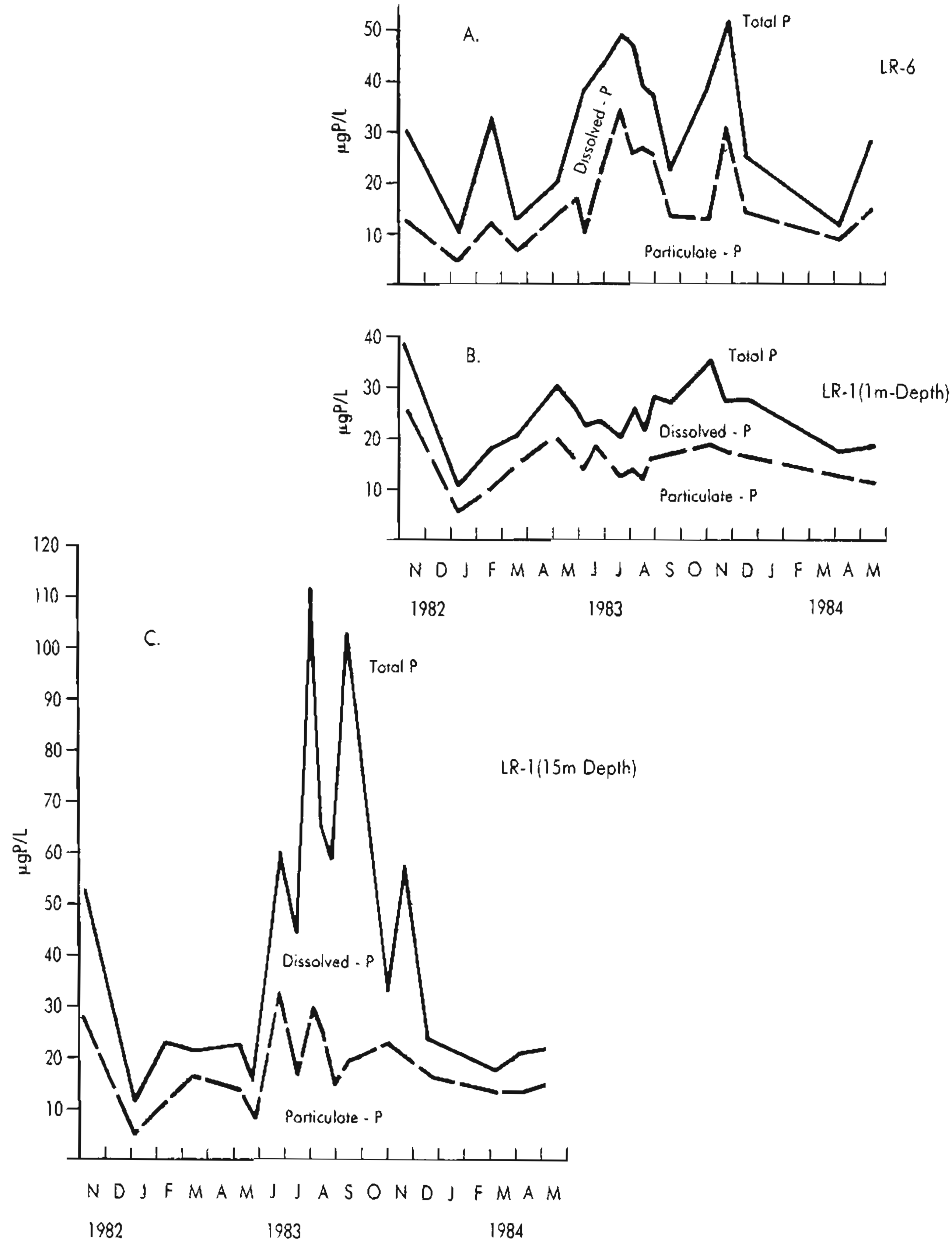


Figure 4-5 *Total-P, Dissolved-P, and Particulate-P Concentrations, (LR-1,LR-6): November 1982 through May 1984.*

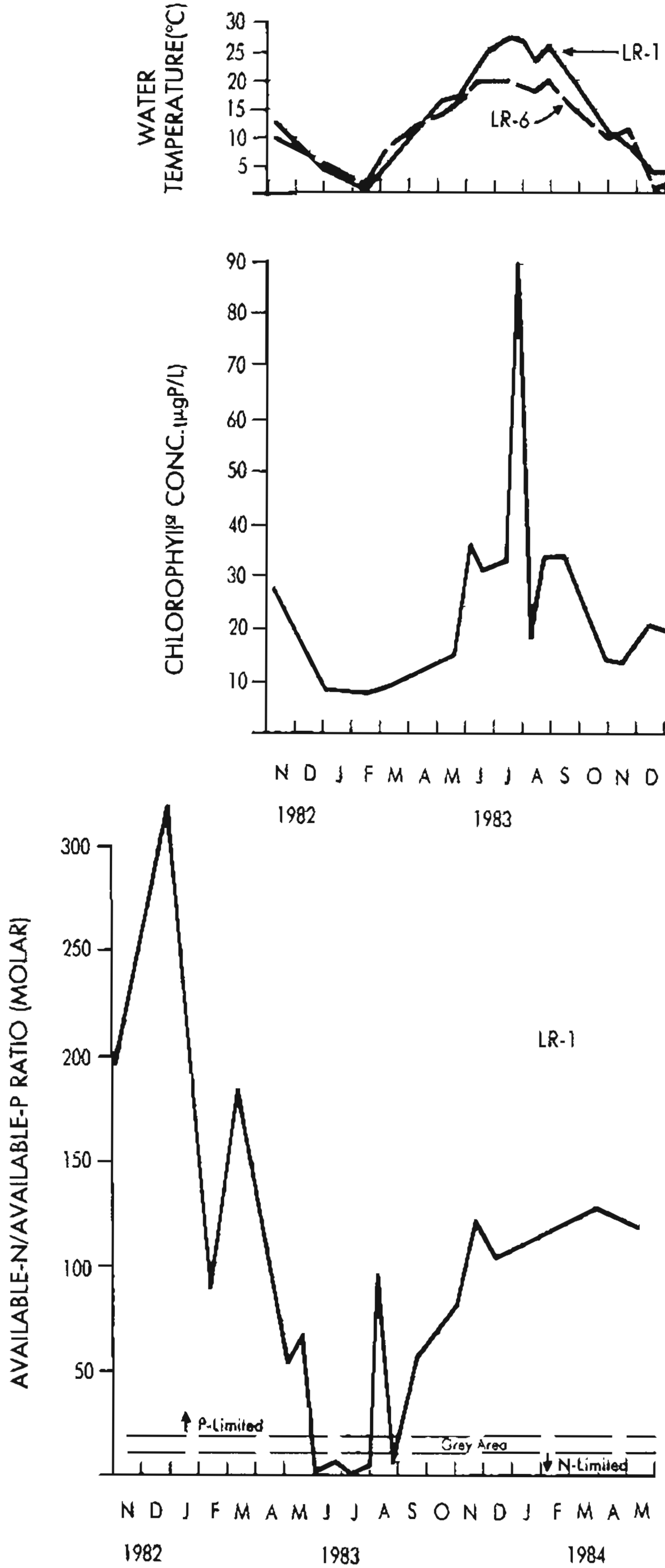


Figure 4-6 *Water Temperature (LR-1 & LR-6), Chlorophyll **a** Concentration (LR-1), and Available-Nitrogen/Available-Phosphorus Ratio (LR-1), November 1982 through May 1984.*

4.1.3.2.4 The Phytoplankton. The *phytoplankton community* provides the interface between the physical/chemical lake environment and the food chain. As such, the phytoplankton community reflects lake quality directly. Ecological characteristics of the phytoplankton community, such as species diversity and composition, dominance, size, standing crop, rate and intensity of succession, and historical shifts, give specific indication of lake quality.

The Lake Ronkonkoma phytoplankton community exhibited four important features that characterized the overall nutritional and productive nature of the lake.

- Species diversity was low, both in number of species and evenness (equability) of allotment of individuals among species.
- The community was generally dominated (biovolume) by either Cyanophyta (blue-green algae) or Chlorophyta (green algae) throughout most of the growing season, with dominance concentrated in 2-to-4 species.
- Phytoplankton standing crop was characterized by summer maxima in density and biovolume, and a continued condition of phytoplankton *bloom*.
- The pattern of seasonal succession was marked and intense.

These community features of the phytoplankton, individually and collectively, indicate the advanced eutrophic quality of Lake Ronkonkoma.

Species diversity in the Lake Ronkonkoma phytoplankton community was low in both richness (variety) and evenness (equability). The low diversity values (Shannon-Weiner 1949,Pielou 1975, $H=\Sigma piLogpi$) are indicative of a nutritionally enriched, productive lake water environment. The total number of species tabulated over the growing season was 36. The maximum number of species present on any one sampling date was 22, the least 15, while the number of species abundant enough for quantification ranged between 18 and 7. The lowest number of quantifiable species corresponded to the peaks in biovolume (June 28, 10 species) and density (August 2, 7 species).

Fewer total species displaying abundance concentrated among a small number of the species, indicates more restrictive, specialized ecological conditions, and can result in a shorter food chain with potentially dramatic population oscillations (Odum 1971, Krebs 1978). The species diversity in Lake Ronkonkoma, expressed as the Shannon-Weiner Index (See Krebs 1978, p. 456), for each sampling date is listed in Table 4-4.

Table 4-4

Species Diversity In Lake Ronkonkoma

DATE 1983	SPECIES DIVERSITY H	EQUABILTY **E** (Range 0-1)
May 10	0.92	0.80
24	0.90	0.72
June 14	0.80	0.74
28	0.31	0.33
July 19	0.30	0.30
August 2	0.01	0.01
16	0.62	0.54
30	0.42	0.39
September 27	0.41	0.39
November 1	0.91	0.79

The pattern of diversity indices depicts an increasingly narrow range of environmental lake conditions depleted nitrogen and elevated pH as the season progressed into mid-summer. By August 2, diversity (H) had reached an extremely low value with seven quantifiable species observed. Anabaena comprised 99 percent of the total density. The evenness component (E) also dipped to a minimum on August 2. The narrow range of environmental conditions by mid-summer is best exemplified by the depleted available nitrogen reservoir combined with the warmest water temperature of the year and a photosynthetically elevated pH. Immediately following the August 2 trough in diversity components, phytoplankton populations exhibited the greatest oscillations of the season.

Ecological dominance (as biovolume) within the phytoplankton was concentrated into very few species and consistent between two groups, *Chlorophyta* (grass-green algae) and *Cyanophyta* (blue-green algae). The dominant species for each sampling date are shown in Table 4-5. The sampling data for this table appear in Table 4-6.

On all sampling dates, only four species accounted for more than 70% of the density and more than 68% of the biovolume. In fact, the two most prevalent species in each catgory accounted for a mean of 76% of the density and a mean of 76% of the biovolume over the entire growing season.

- The mean density in the four dominant species was equal to 87 percent, and the range was 70-99 percent.
- The mean biovolume in the four dominant species was equal to 90 percent, and the range was 68-97 percent.
- The mean density in the two dominant species was equal to 75 percent, and the range was 45-99 percent.
- The mean biovolume in the two dominant species was equal to 76 percent, and the range was 49-92 percent.

The Lake Ronkonkoma phytoplankton communities were essentially 2-to-4 species communities, relatively unstable in nature, and subject to large, sudden large changes in abundance and composition. Severe population oscillations in phytoplankton communities with highly concentrated dominance are most likely induced by meteorological conditions (Stoermer, 1978, Odum 1971).

The pattern of phytoplankton standing crop as estimated by chlorophyll a concentration (Figure 4-6) and biovolume measurements (Figure 4-7) further confirmed the enriched and productive quality of Lake Ronkonkoma. Phytoplankton biomass attained the greatest magnitude in late June and densities were greatest in early and late August (Figure 4-7). Such summer maxima can occur through continual replenishment of phosphorus to the euphotic zone, (if phosphorus is limiting) which in turn is probably most directly influenced by vertical mixing.

The seasonal succession of phytoplankton populations in the most dilute lake nutrient environments has been described as weak and difficult to characterize between sampling dates during summer stagnation (Stoermer, 1978). This is apparently due to continual nutrient limitation. As eutrophication progresses, intensive blooms are frequent, resulting in transient maxima during the summer as nutrient limitation is relaxed. Phytoplankton populations then become mostly light limited in a pattern of succession controlled by meteorological conditions. Seasonal succession under advanced eutrophic conditions is strong and unpredictable in the short term.

The seasonal succession of species in Lake Ronkonkoma was intense, and more rapid approaching and continuing through mid-summer. An index of community similarity can illustrate the degree of species succession by comparing species changes between sampling dates, or by comparing all sampling dates to one date treated as a baseline.

The index used here is (See Odum 1971,p144) simply:

$$S = \frac{2c}{A+B}$$

S = degree of similarity, or 1-**S** = degree of dissimilarity
A = number of species in sample A
B = number of species in sample B
c = number of species common to both samples.

Table 4-5
Phytoplankton Dominance

1983 DATE	DENSITY RANK	SPECIES	% of TOTAL DENSITY	BIOVOLUME RANK	SPECIES	% of TOTAL BIOVOLUME
May 10	1	Asterionella formosa	24%	1	Coelospharium nagelianum	80%
	1	Scenedesmus quadracauta	23%	2	Cosmarium sp.	6%
	3	Cosmarium sp.	16%	3	Staurastrum sp.	3%
	4	Cryrtomonas erosa	7%	4	Asterionella formosa	3%
May 24	1	Scenedesmus arculatus	28%	1	Coelospharium nagelianum	80%
	2	Asterionella formosa	22%	2	Microcystis aeruginosa	10%
	3	Scenedesmus quandracauta	14%	3	Cosmarium sp.	2%
	4	Cosmarium sp.	11%	4	Cryptomonas ovata	2%
June 14	1	Coelospharium nagelianum	38%	1	Cosmarium sp.	51%
	2	Cosmarium sp.	22%	2	Cryptomonas ovata	23%
	3	Sphaerocystis schroeteri	11%	3	Pediastrum duplex	6%
	4	Franceia droescheri	6%	4	Staurastrum sp.	6%
June 28	1	Cosmarium sp.	83%	1	Cosmarium sp.	81%
	2	Franceia droescheri	6%	2	Coelospharium nagelianum	9%
	3	Sphaerocystis schroeteri	4%	3	Staurostrum sp.	5%
	4	Staurastrum sp.	3%	4	Cryptomonas erosa	0.6%
July 19	1	Anabaena sp.(#1)	80%	1	Staurastrum sp.	63%
	2	Staurastrum sp.	14%	2	Ceratium hirudinella	17%
	3	Cosmarium sp.	2.5%	3	Coelospharium nagelianum	8%
	4	Sphaerocystis schroeteri	2.0%	4	Cosmarium sp.	7%
August 2	1	Anabaena sp.(#1)	99%	1	Anabaena sp. (#1)	62%
	2	Pediastrum simplex	0.06%	2	Ceratium hirudinella	17%
	3	Ceratium hirudinella	0.05%	3	Microcystic Aeruginosa	10%
	4	Staurastrum sp.	0.04%	4	Staurastrum sp.	5%
August 16	1	Anabaena sp. (#2)	53%	1	Cryptomonas ovata	28%
	2	Anabaena sp. (#1)	29%	2	Anabaena sp. (#2)	21%
	3	Cosmarium sp.	3.2%	3	Cosmarium sp.	11%
	4	Cryrtomonas ovata	2.5%	4	Anabaena sp. (#1)	8%
August 30	1	Anabaena sp. (#1)	59%	1	Anabaena sp. (#1)	29%
	2	Anabaena sp. (#2)	33%	2	Anabaena sp. (#2)	24%
	3	Sphaerocystis schroeteri	6%	3	Aphanocapsa elachista	16%
	4	Cryptomonas ovata	0.7%	4	Cryptomonas ovata	15%
Sept. 29	1	Anabaena sp. (#2)	55%	1	Anabaena sp. (#2)	44%
	2	Anabaena sp. (#1)	39%	2	Anabaena sp. (#1)	20%
	3	Chroococcus limneticus	2.2%	3	Melosira sp.	16%
	4	Melosiro sp.	1.2%	4	Microcystis aeruginosa	5%
					Coelospharium nagelianum	5%
Nov. 1	1	Cryptomonas erosa	30%	1	Coelospharium nagelianum	86%
	2	Chroococcus limneticus	15%	2	Cryptonmonas ovata	6%
	3	Fragillaria construens	14%	3	Microcystis aeruginosa	4%
	4	Scendesmus quadracauta	11%	4	Melosiora sp.	1.2%

Table 4-6
Phytoplankton Species Composition and Density, LR-1 (1 meter depth)
(May through November, 1983)

SPECIES	BIOVOLUME (μ^3)		May 10 No. mL^{-1}	May 24 No. mL^{-1}	June 14 No. mL^{-1}	June 28 No. mL^{-1}	July 19 No. mL^{-1}	August 2 No. mL^{-1}	August 16 No. mL^{-1}	August 30 No. mL^{-1}	Sept. 27 No. mL^{-1}	Nov. 1 No. mL^{-1}
CHLOROPHYTA												
Ankistrodesmus falcatus	605		54	6	-	-	-	-	144	*	120	33
Botryococcus braunii	1,475		-	*	-	-	-	*	*	-	-	6
Coelastrum sp.	660		96	-	*	-	-	-	-	-	-	-
Cosmarium spp.	1,270		228	258	7,080	24,093	900	180	475	*	30	15
Elakotothrix gelatinosa	120		-	60	*	*	*	-	-	-	-	-
Euastrum sp.	10,000		-	6	*	*	*	-	-	-	-	*
Franceia droescheri	100		-	-	2,006	1,754	*	*	-	-	-	-
Kirchneriella sp.	65		-	*	-	-	-	-	-	-	-	-
Oocystis sp.	325		*	6	1,880	*	*	*	-	180	-	-
Pediastrum duplex	900		3	42	1,200	64	16	*	132	-	*	-
Pediastrum simplex	525		-	10	240	-	16	32	288	300	240	22
Scenedesmus arcuatus	245		-	672	126	-	*	*	271	-	-	-
Scenedesmus quadricouda	300		324	336	-	-	-	-	271	120	180	180
Schroedaria setiqua	80		-	-	-	-	-	-	-	*	-	-
Sphaerocystis schroeteri	110		-	-	3,600	1,260	720	*	*	2,800	-	-
Staurastrum spp.	2,050		84	12	510	840	5,100	210	180	*	-	-
Tetraedron minimum	115		-	-	*	*	-	*	-	90	30	-
BACILLARIOPHYTA												
Asterionella formosa	435		336	534	-	-	-	-	-	-	-	-
Fragillaria construens	215		-	-	-	-	-	-	-	-	*	231
Fragillaria crotonensis	845		42	90	360	*	-	*	234	-	-	66
Melosira sp.	2,500		51	-	-	-	120	-	126	-	405	60
Nitzshia sp.	1,100		6	-	-	-	-	-	*	-	-	22
Synedra sp.	315		24	-	-	-	-	-	-	-	-	-
CHRYSOPHYTA												
Dindbryon bavaricum	735		-	6	-	-	-	-	-	-	-	-
Mallomomnas sp.	400		-	-	-	-	-	-	-	-	60	-
CRYPTOPHYTA												
Cryptomonas erosa	300		96	174	-	814	-	-	249	*	-	480
Cryptomenas ovata	4,350		*	60	940	*	*	*	362	360	30	165
CYANOPHYTA												
Anabaena sp. (#1)	100		-	-	-	-	28,350	51,150	4,200	30,750	13,050	-
Anaboena sp. (#2)	150		-	*	1,631	180	-	-	7,722	17,355	18,525	-
Anabaena spiroides	300		27	*	-	-	*	-	-	*	-	-
Aphanocapsa elachista	115,900	(Colony)	-	-	-	-	-	-	-	15	-	-
Chroococcus limneticus	115	(Single Cell)	-	48	*	-	240	-	-	120	720	240
Coelosphaerium nagelianum	115,900	(Colony)	36	96	-	30	11	2	1	7	3	90
Coelosphaerium nagelianum	30	(Single Cell)	-	-	12,158	-	-	-	-	-	-	-
Microcystis aeruginosa	115,900	(Colony)	-	12	-	3	-	7	-	-	3	4
PYROPHYTA												
Ceratium hirudinella	50,305	-	-	-	1	2	9	28	6	7	1	-
-	-	TOTAL	1,407	2,428	31,732	29,040	35,482	51,609	14,661	52,184	33,397	1,614

* Trace

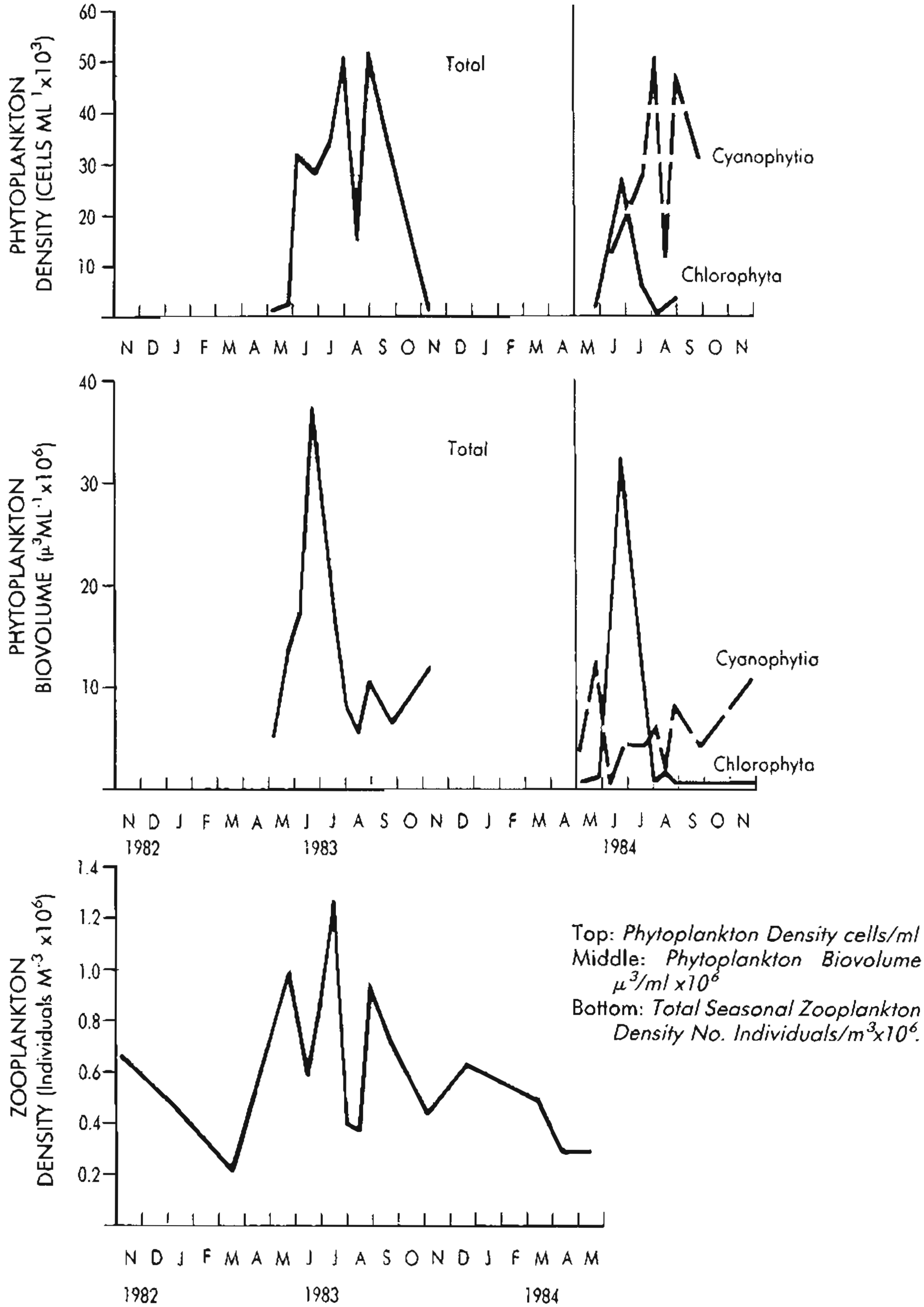


Figure 4-7 *Plankton Abundance, (November 1982 through May 1984)*

The Series I comparisons in Table 4-7 illustrate the degree of similarity between communities on successive sampling dates (ie. SX100) in terms of numbers of species in common. Included is the listing of occasions on which the most dominant species on the first sampling date remained most dominant on the second sampling date. The most similar communities occurred just preceeding the seasonal maxima in biovolume (70% of species in common) and density (71% of Species in Common). Immediately preceding and following the most similar communities, the number of species in common between sampling dates ranged between 50% and 60%, even though the total number of species potentially in common was low. During only one period did the species of greatest density remain most dominant (7/19-8/2, 1983), and during two periods the species of greatest biovolume remained dominant (5/10-5/24, 6/14-6/28, 1983).

The Series II comparisons (see Table 4-7) are presented in order to demonstrate the total degree of succession throughout the growing season. The baseline community (May 10) was chosen for the similarity comparison since the greatest species diversity ($H=0.92$, $E=0.80$) occurred on that date. If succession were subtle between samplings and among all samples, one might expect either a moderate to gentle decline in similarity over time, or similarity values which were consistently near 0.90-1.0. The August 30 phytoplankton community either shared only two species in common with the May 10 community, or was 85% dissimilar. The remaining summer communities shared a mean of 40% of species with the May 10 community. At no time during the June through September period did the May 10 dominant species (density or biovolume) return to dominance.

Table 4-7
Series I and II Comparisons

Series I - *Degree of Similarity* | Series II - *Total Degree of Succession Throughout the Growing Season*

DATES of COMPARISON	% of SPECIES in COMMON (Sx100)	DOMINANT SPECIES -UNCHANGED- Density	Biovolume	DATES of COMPARISON	% of SPECIES in COMMON (Sx100)	DOMINANT SPECIES -UNCHANGED- Density	Biovolume
5/10-5/24	57%	No	Yes	5/10-5/24	56%	No	Yes
5/24-6/14	52%	No	No	5/10-6/14	30%	No	No
6/14-6/28	70%	No	Yes	5/10-6/28	42%	No	No
6/28-7/19	60%	No	No	5/10-7/19	42%	No	No
7/19-8/2	71%	Yes	No	5/10-8/2	29%	No	No
8/2-8/16	55%	No	No	5/10-8/16	62%	No	No
8/16-8/30	52%	No	No	5/10-8/30	15%	No	No
8/30-9/27	69%	No	No	5/10-9/27	36%	No	No
9/27-11/1	64%	No	No	5/10-11/1	57%	No	Yes

Phytoplankton species succession in Lake Ronkonkoma can also be evaluated according to *morphology*, or species form. During May, the dominant form (as biovolume) was a large colonial blue-green (*Coelospharium nagelianum*, 115,900 μ^3). The colony is composed of 3000 to 4000 individual cells in a gelatinous matrix, an adaptation which aids floatation and resistance to grazing pressure. The dominant form shifted to a large single celled *Cosmarium sp* (1270 μ^3 ea.) by June. The size and morphological projections of the cell walls in *Cosmarium* would also serve to render this alga unmanageable to many zooplankton grazers. Finally, throughout the period of most intensive nitrogen depletion and warmest water temperature, two filamentous *Anabaena* species, equipped with heterocysts specialized for nitrogen fixation, completely dominated the community (density and biovolume), alternating the top two positions of dominance. In summation, not only were individual species changes involved in the succession of species, but specialized morphologies, and physiologically (N_2 fixation) best suited to the changing internal lake environmental pressures,markedly succeeded one another over the growing season.

4.1.3.2.5 The Zooplankton. The *zooplankton* comprise the second trophic level in the aquatic food chain. They exert grazing pressure on the first trophic level (phytoplankton) and influence lake nutrient dynamics through remineralization. Zooplankton also serve as a food source for at least one developmental stage in the life cycle of all pelagic fish. Included among the most important characteristics of the zooplankton community are temporal patterns in total abundance and species composition, size structure of the community, and the relative abundance of major crustacean groups.

The Lake Ronkonkoma zooplankton community was characterized by three prominant features:

- Three abundance maxima which occurred in the spring, mid-summer, and late-summer corresponding to shifts in food quality and quantity
- A community dominated by small sized herbivorous species during periods of abundant high quality food, and dominated by large herbivorous species during periods of lower quality foods and high turbidity
- A community composition, according to proportions of major crustacean groups, which indicated an advanced stage of lake eutrophication.

Zooplankton abundance maxima occurred in late-spring (May 24, 1×10^6 individuals/m^3), mid-summer (July 19, 1.29×10^6 individuals/m^3), and late-summer (August 30, 0.95×10^6 individuals/m^3) (See Table 4-8 and Figure 4-8). Each peak in zooplankton abundance followed the peaks in high quality foods by approximately two weeks. High quality foods are herin defined as edible (non-toxic),manageable phytoplankton with a mean diameter of less than 50um, as established by the work of Porter (1973, 1977), Porter and Orcutt (1980), and others. Table 4-9 liststhe proportions of high quality foods potentially available to herbivorous zooplankton over the 1983 growing season.

Each maximum in zooplankton abundance was followed immediately by a trough in the seasonal abundance pattern (reductions of 40% to 60% of total abundance) corresponding to major shifts in the phytoplankton community.

The occurrence of the abundance maximum in late-spring was most likely in response to warming water temperature and the spring pulse of high quality foods comprised (by density) predominantly of diatoms and green algal species. The first steep decline in abundance (June 14) followed a late-spring increase in the blue-green alga *Coelospharium nagelianum*, which is a colonial species too large to serve as a zooplankton food source. The mid-summer zooplankton abundance maximum (July 19) appeared just after the greatest high quality food abundance was observed during the growing season, and coincided with the warmest water temperature of the year. The beginning of August marked another sharp and major decline in zooplankton abundance, concurrent with a shift in phytoplankton species composition to a dominance of *Anabaena spp.* (noxious as a food source). The final abundance maximum of the season followed the partial resurgence of green algal species and other edible phytoplankton during mid-August.

The general pattern and magnitude of zooplankton abundance in Lake Ronkonkoma more closely resembled those of smaller, enriched pond communities rather than those of larger, and more stable lake ecosystems. Population oscillations in small ponds can be numerous and rapid, as observed in Lake Ronkonkoma. Densities of crustacean zooplankton in small ponds can reach 10^6 individuals/m^3, as in Lake Ronkonkoma, while densities found in large lakes normally fall within the range of 10^4 to 10^5 individuals/m^3.

The size structure of the zooplankton community (i.e. properties of small sized and large sized species) also provides useful information about the nature of the lake ecosystem. For example, size structure can indicate the intensity of fish predation. Under heavy fish predation, the larger, more visible zooplankton populations are more efficiently consumed and thereby held in check, while the smaller species are less efficiently preyed upon and attain community dominance (Hrbacek, et al, 1961; Brooks & Dodson, 1965). In addition, size structure can lend insight into the cycling of plant nutrients within the lake. Communities dominated by smaller zooplankton have been found to cycle soluble phosphorus via remineralization at a greater rate than those dominated by larger zooplankton (Henry, 1985). Finally, size structure can indicate the path of energy transfer up the food chain and degree of grazing pressure on the phytoplan

Table 4-8
Summary of Zooplankton Density Collected from the Epilimnion LR-1
(November 1982 through May 1984)

SPECIES	SAMPLE DATE ($\#s/m^3$) 11-9-82	1-6-83	3-16-83	5-24-83	6-14-83	6-28-83	7-19-83	8-2-83	8-16-83	8-30-83	9-27-83	11-1-83	12-20-83	3-20-84	4-10-84	5-7-84
CLADOCERA																
1. Daphnia retrocurva	4,931	17,667	1,500	131,042	17,667	32,222	54,500	3,500	12,250	105,625	-	625	2,500	11,333	4,722	22,250
2. Daphnia galeata	6,389	12,500	-	14,375	2,500	2,500	1,500	-	-	15,000	-	-	-	-	-	-
3. Daphnia catawba	-	1,000	-	312	3,000	7,500	20,875	2,000	5,000	26,250	1,071	-	417	-	-	-
4. Daphnia parvula	4,167	31,833	3,733	109,375	8,750	21,667	6,750	500	1,500	15,625	-	625	4,583	2,667	5,417	11,083
5. Ceriodaphnia quadrangula	99,167	-	-	58,229	178,333	182,222	253,667	27,500	28,500	95,625	201,071	32,083	417	-	-	-
6. Bosmina longirostris	450,000	290,917	80,667	376,563	9,375	40,000	669,500	36,000	44,167	280,000	268,214	45,313	251,111	78,333	94,167	172,750
7. Chydorus sphaericus	28,125	750	2,000	136,771	218,167	365,138	6,500	11,400	19,000	88,750	27,381	159,583	19,441	3,000	5,972	13,333
8. Diaphanosoma leuchtenbergianum	10,417	-	-	5,729	21,500	18,889	102,375	233,667	179,833	175,625	192,261	71,250	-	-	-	1,000
COPEPODA																
1. Diaptomus pygmeus (females)	17,708	16,583	5,250	28,125	12,333	12,083	10,250	27,333	35,167	63,125	42,976	26,354	24,028	10,500	35,278	22,250
(males)	9,583	11,750	4,250	7,292	11,667	7,500	500	4,500	10,667	26,875	1,786	3,229	8,194	6,833	9,861	1,833
2. Cyclops vernalis	44,305	92,833	100,083	89,678	1,000	-	-	-	-	-	-	78,229	233,889	367,333	135,278	50,000
3. Cyclops bicuspidatus thomasi	10,417	18,853	21,583	3,750	19,000	15,694	5,500	7,625	7,625	15,000	3,929	31,250	107,361	17,833	1,667	-
4. Mesocyclops edax	-	-	-	46,875	93,167	152,361	160,500	53,167	44,833	38,750	1,786	-	-	-	-	2,833
Total Density ($\#s/m^3$)	674,792	492,667	219,083	1,007,813	595,459	857,778	1,290,417	401,192	387,042	946,250	739,405	447,292	651,110	497,832	292,360	297,334

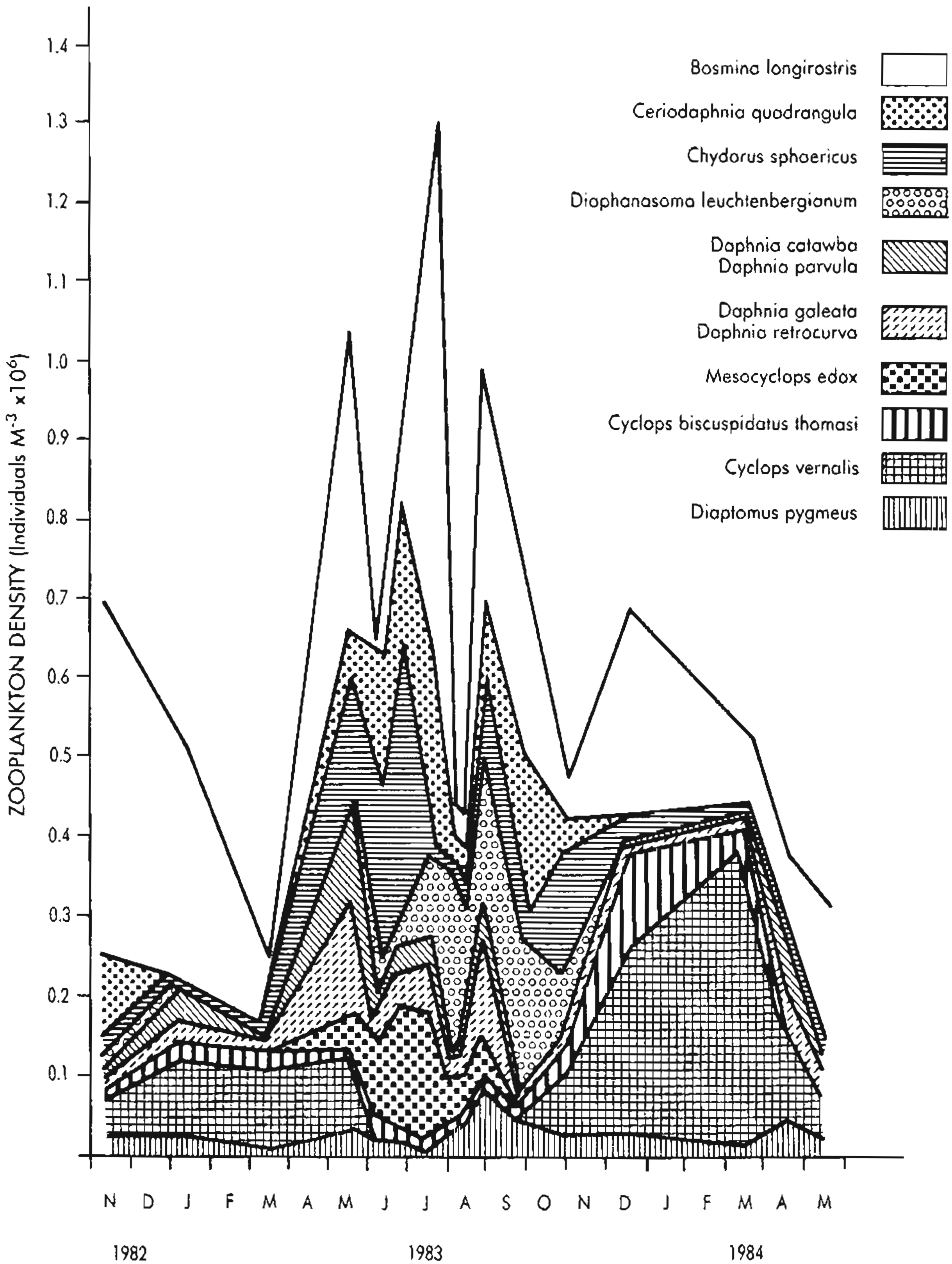


Figure 4-8 *Temporal Zooplankton Community Composition and Abundance at LR-1, November 1982 through May 1984.*

Table 4-9
Availability of Food for Zooplankton

SEASON	DATE	% HIGH QUALITY FOOD Density	Biovolume
Late-Spring	May 10	96%	19%
	24	88%	8%
	June 14	54%	73%
	28	99%	87%
Mid-Summer	July 19	19%	72%
	August 2	1%	8%
	16	16%	37%
	30	7%	5%
Late-Summer	September 27	3%	21%
	November 1	69%	4%

kton standing crop. Smaller zooplankton species tend to rely most heavily on detritus and bacteria associated with a very productive phytoplankton community, while the larger zooplankton directly consume phytoplankton (Gliwicz 1969 a, b, 1975; Gliwicz & Hillbricht-Ilkowska 1972; Hillbricht-Ilkowska et al. 1966, 1972; Hillbricht-Ilkowska and Spodniewska 1969; Hillbricht-Ilkowska and Weglenska 1970; see Sprilles 1980).

The Lake Ronkonkoma zooplankton community was dominated by small species (*Bosminia, Ceriodaphnia, Chydorus*) throughout the growing season, except for one short period during August. (See Figure 4-8). The August Community was dominated by *Diaphanasoma luechtenbergianum*, a conspicuously large cladoceran, while the relatively large *Diaptomus* and *Daphnia* species also increased in density. The lasting dominance of the smaller species indicated a higher level of fish predation, accompanied by minimal grazing pressure on the phytoplankton standing crop, and relatively rapid turnover of soluble phosphorus in the epilimnion. The period dominated by the large species occurred when water clarity was lowest (secchi depth less than 0.5m). This lack of clarity may have provided a refuge from predation by fish . In addition, the larger species may have been less susceptible to feeding inhibition caused by the noxious *Anabaena spp., Daphnia* and *Diaptomus* exhibit selective feeding behavior whereby they are able to exclude undesirable foods and consume only the edible phytoplankton (Gliwicz, 1980; Wilson, 1973; Porter 1973, McQueen, 1970; Bowers, 1977; Jones, unpublished).

Finally, the relative abundance of crustacean groups can yield information about the degree of eutrophication existing in a lake. The usefulness of the ratio of calanoid copepods to cladocerans plus cyclopoid copepods as an indicator of trophic conditions, has been demonstrated in the Laurentian Great Lakes (Gannon and Stemberger, 1978). In theory, calanoid copepods are ecologically better suited to oligotrophy than are cladocerans and cylcopoid copepods. Therefore, high ratio values can be found in very unproductive, nutrient-poor waters. The ratio of calanoid copepods to cladocerans plus cyclopoid copepods in Lake Ronkonkoma over the growing season of 1983 averaged 0.08 (range; 0.01 to 0.21), an extremely low value indicating advanced eutrophication.

4.1.3.2.6 Indicator Bacteria of Lake Ronkonkoma. Bacterial samples from lake stations (LR-1 through LR-5), the Great Bog Stream, and from the Brookhaven and Islip Town Beaches were analyzed for total coliform and fecal coliform concentrations during the summer months of 1983. The results of analyses are listed in Appendix B,Part 2 - Table 1.

Total and fecal coliform concentrations were very low (ie. below or near quantification limits) at all lake stations on all sampling dates. Samples taken from the waters of Brookhaven and Islip Town Beaches also yielded very low coliform concentrations.

Samples from the Great Bog Stream (see the Bog Stream) consistently produced quantifiable bacterial counts. The bog serves as habitat for many water fowl and other warm-blooded animals throughout the year, and therefore the coliform concentrations were not unexpected. However, coliform bacterial contribution to the open water of the lake during dry weather can be considered negligible (probably due to die-off) since concentrations at the lake stations were very low throughout the summer.

4.1.3.3 Trophic Status. A recently completed study on the trophic status of Lake Ronkonkoma appears in Appendix F.

4.1.3.4 The Bog Stream. The stream that drains the bog at the northern end of Lake Ronkonkoma is the sole inlet stream to the lake. Stream base flow consists of groundwater underflow and surface water flow from the bog. This flow is augmented during rainfall conditions with direct precipitation on the bog, stormwater runoff and pumpage from three recharge basins. During periods of high water levels in 1979 and 1984, the stream rose, expanded and breached CR16, and the bog and lake were joined as one body of water. At this time there was no obvious flow from the bog to the Lake. When this occurs, it is possible, under appropriate atmospher conditions, for water from the lake to move northward into the bog.

Under differing rainfall conditions, the bog can function in two ecologically opposite ways with respect to the lake. During and following a moderate rainfall, the bog can trap and hold runoff materials (such as bacteria, suspended solids and particulate plant nutrients) preventing them from reaching the lake. Greater amounts of precipitation can flush the bog making it a source of previously sedimented runoff materials and decomposition products commonly present in the bog. Fortunately, under normal conditions, an undisturbed bog functions as a buffer, protecting the lake from direct input of runoff from the watershed.

The bog also provides other ecological benefits. It is a breeding habitat for a variety of water fowl, passerine birds, and mammals. If stream water quality is suitable, the stream from the bog and areas within the bog can also serve a spawning habitat for fish.

The bog stream is a sand bottom stream whose dimension and shape vary over time. High flows have scoured the bottom clean of growth and debris, and have straightened and deepened the channel. Under low flow conditions, the channel slopes gently to the shore with an irregular bottom covered by a lush filamentous algal growth. Water color was routinely brown to brownish-black with an apparent abundance of humic substances from the bog. Dissolved oxygen concentrations were routinely very low, especially from May through September (Figure 4-9). A strong odor of hydrogen sulfide (H_2S) was present in water samples throughout the same time period. Concentrations of dissolved and particulate phosphorus, ammonia-nitrogen, and nitrate-nitrogen were greater in the stream than in the lake waters, with the largest differences occurring during the summer and winter months.

Alkalinity and conductivity values were also higher (by 20% to 40%) in the stream water than in the lake (Figure 4-3). These higher values may reflect the products of organic production/decomposition, which are characteristically of greater magnitude in a marsh than in a lake.

Lastly, the pH of the stream water exhibited greater acidity then that of lake water. Organic acids of dissolved plant materials from the marsh are partially responsible for the lower pH values. In addition, greater acidity results from the microbial respiration of decomposition, which is the prevalent metabolism in marsh waters.

In summation, the bog can function as both a sink preventing the movement of organic and inorganic materials into the lake and as a source of such materials. The frequency and magnitude of buffering and export capacity is most likely dependent upon the season of the year, and the frequency, intensity, and duration of storm events. To adequately evaluate the role of the bog and quantify the impacts upon Lake Ronkonkoma, measurements of stream flow, and water quality sampling should occur during ambient and rainfall conditions for a period of several years. Such a determination would be exceedingly difficult without a multiyear sampling program.

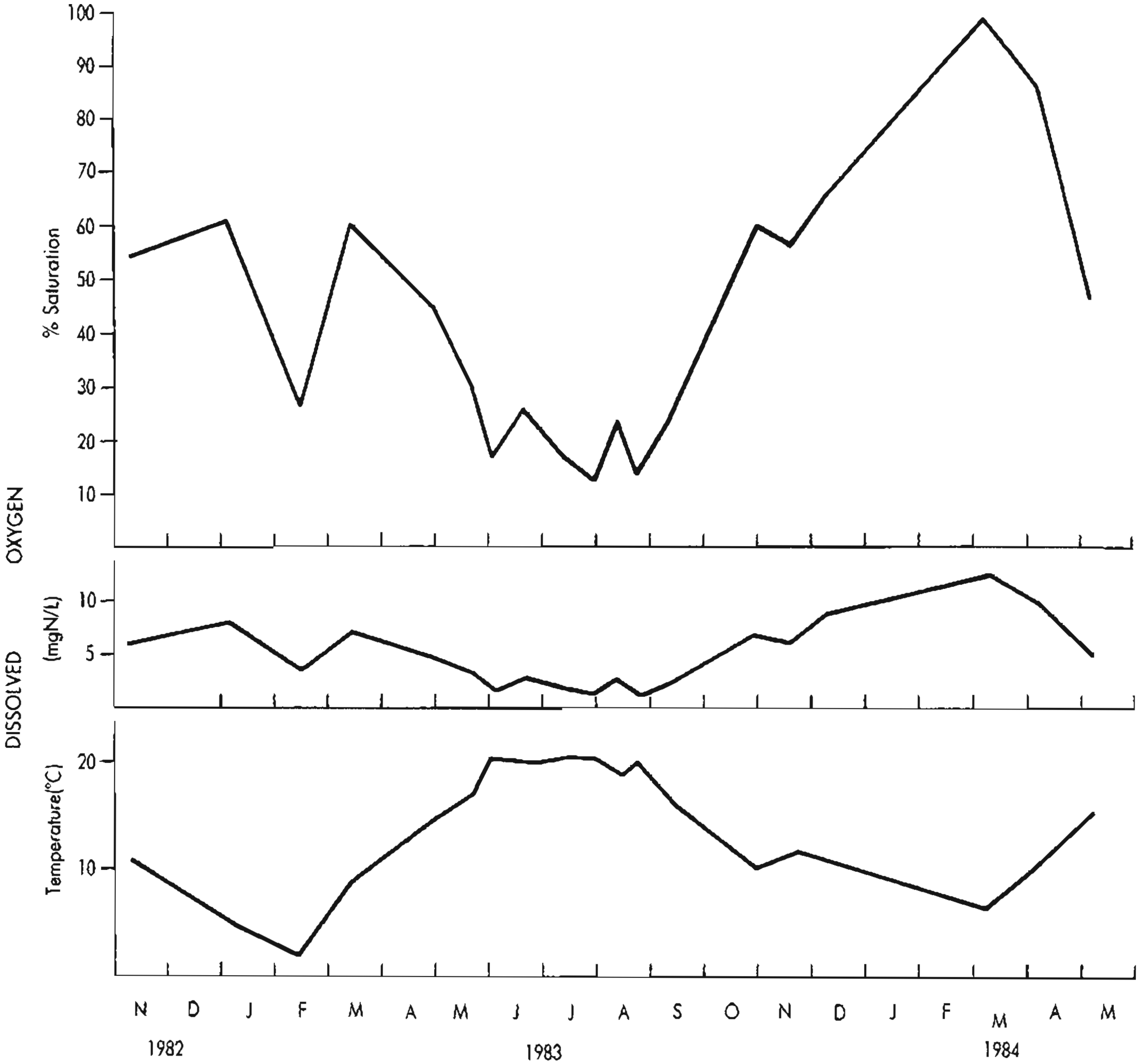


Figure 4-9 *Dissolved Oxygen Percent Saturation and Concentration, and Water Temperature, Great Bog Tributary Water (LR-6), November 1982 through May 1984.*

4.2 LAKE WATER QUALITY SURVEY DURING WET WEATHER CONDITIONS

4.2.1 Introduction. A main task of this project was the sampling of the lake during wet weather conditions to facilitate estimation of the relative impact of rainfall and runoff on the lake water quality. For this task, ten sites around the perimeter of the lake were selected. These sites, numbered LR-11 through LR-20 (Fig. 4-10), were sampled during, or within twenty-one hours following, thirteen rainstorms between March 1983 and October 1984. As the study progressed, an additional site (LR-21) was also sampled. The site was located near Browns Road, at the northeast corner of the bog to the north of Lake Ronkonkoma. This site is the point at which water is discharged into the bog from three recharge basins located approximately one-half mile to the north.

4.2.2 Site Descriptions

LR-11 is located at the north end of Lake Ronkonkoma adjacent to the Bavarian Inn. The stream from the bog flows south through a culvert under Smithtown Boulevard (County Road 16) and mixes with the water of Lake Ronkonkoma at the point where the samples were collected.

LR-12 is near the intersection of Lake Shore Road and Metzner Boulevard. The samples werecollected from the lake at the point where an 18-inch storm sewer pipe discharges runoff from the surrounding areas into the lake.

LR-13 is located near Lake Shore Road, approximately 100 feet north of the Brookhaven Biofiltration Pond. Samples were collected from the lake near the outfall of an 18-inch storm sewer pipe that discharges runoff into the lake.

LR-14 is near the intersection of Lake Shore Road and Old Portion Road. It was selected because it is located at the outfall of the effluent pipe from the Brookhaven Biofiltration Pond. This site was specifically chosen to sample the lake water as it mixed with the effluent from the Biofiltration Pond during or immediately after a rainstorm. However, attempts to monitor the Brookhaven Biofiltration Pond during storm events indicated that the contributory area was not large enough to supply the volume of runoff necessary to ascertain any reduction in contaminant loads attributable to the passage of runoff through the Biofiltration System. Therefore, this site did not provide the anticipate opportunity for the monitoring of the lake water mixed with the effluent from the Biofiltration System.

LR-15 is a sampling site near the discharge point of a 28" x 45" eliptical storm sewer pipe located north of the intersection of Lake Shore Road and Lake Terrace. This system carries the runoff from a contributory area of approximately 30 acres of medium density residential property into the southeast corner of the lake. This storm sewer was also the sampling site used for analyzing runoff discharged into Lake Ronkonkoma during the second half of 1983.

LR-16 is located at the Brookhaven Town Beach bathing area in the southeast corner of Lake Ronkonkoma. This site was chosen for sampling because of its importance as a swimming area during the summer months.

LR-17 is located at the Islip Town Beach bathing area. It is located at the southwestern section of Lake Ronkonkoma off Rosevale Avenue between Lake Crest Lane and Rose Drive. This site was also selected because of its extensive use by bathers during the summer months.

LR-18 is situated at the end of Blythe Road, north of Islip Town Beach. This site was sampled because it contains a storm sewer pipe that conveys runoff from the adjacent roads to the lake.

LR-19 was initially selected because of its location at the end of the outfall pipe from the Islip Biofiltration Pond. The Islip Biofiltration site, like the Brookhaven Biofiltration Pond, has a very small contributory area. Before the study began, the Islip Biofilter was already in a state of serious disrepair. During the course of the study, the biofilter was essentially destroyed. The rising lake water breached a section of embankment enclosing the pond, thereby integrating the pond with the lake. Thus, sampling the treatment capability of the Islip Biofiltration Pond and its effect on the lake become an impossibility.

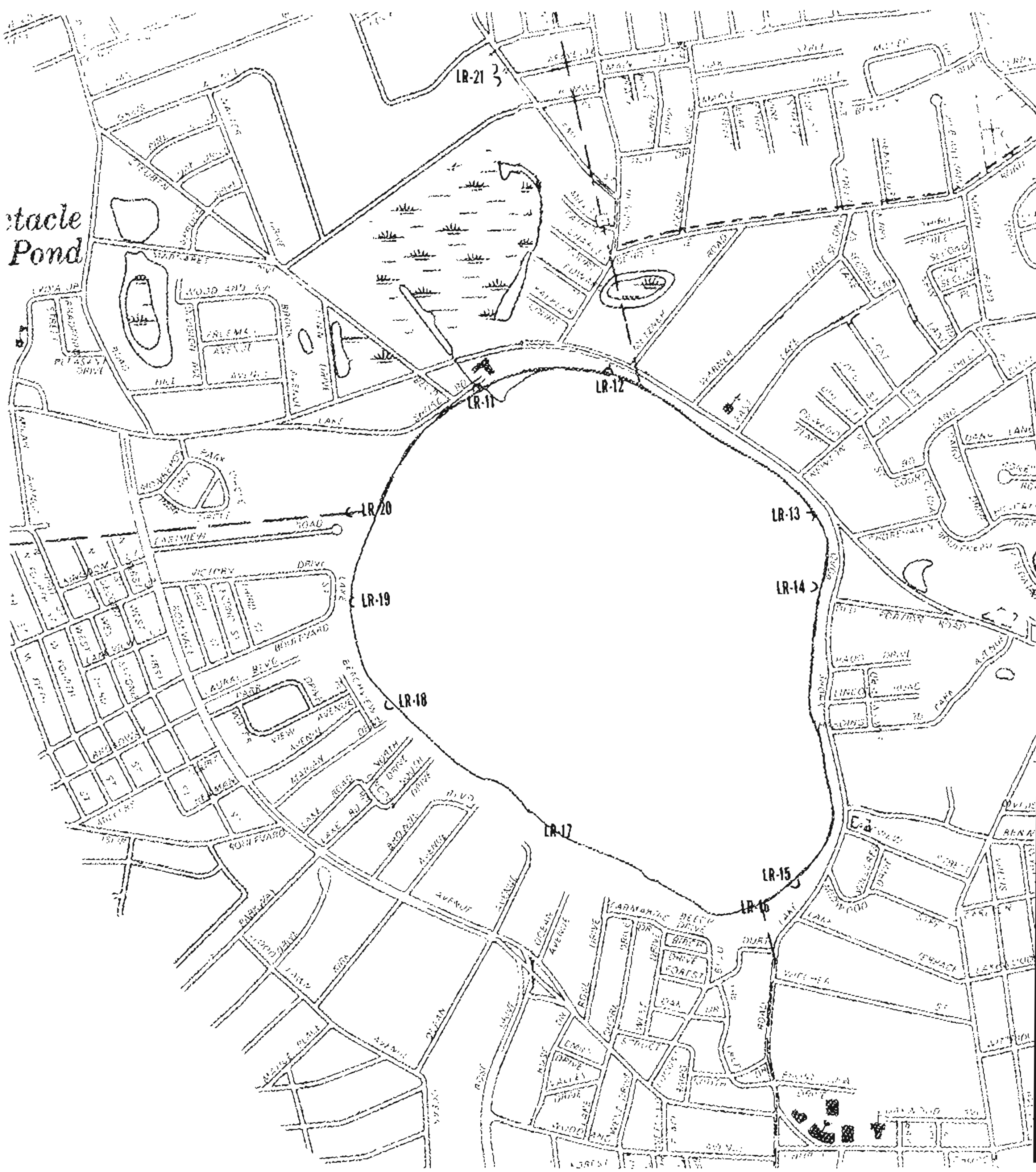


Figure 4-10
WET WEATHER SAMPLING,
MARCH 1983 - OCT 1984

LR-20 is situated immediately north of the Islip Biofiltration Pond at the end of Eastview Avenue. The area was chosen because of its proximity to the discharge point of a storm sewer pipe that conveys runoff from Eastview Avenue into the lake.

LR-21 is located adjacent to the west side of Browns Road at the northeast corner of the bog, north of Lake Ronkonkoma. This is the only sampling site not located on the perimeter of Lake Ronkonkoma. It was selected, after the sampling program was initiated, because it is the point where water from three recharge basins is discharged into the bog. The three recharge basins are located about one-half mile north of this site to the east of the intersection of Nichols Road and Browns Road. Runoff from a medium density residential area is collected in the three basins. To prevent flooding in that area, the three basins were interconnected and water was directed to the bog via a pump station and force main. Sampling occurred at the force main outlet before the effluent mixed with water from the bog.

4.2.3 2. Sampling Program

4.2.3.1 Equipment and Collection Procedures. The eleven sites selected for sampling during wet weather conditions were sampled during or immediately after a rain event. Table 4-10 lists the bacterial and chemical parameters for which analyses were performed. The procedures for collecting these samples are described as follows:

- Bacterial samples were collected by immersion of a sterile container in the lake (LR-11 - LR-20) or in the force main effluent (LR-21). The container was capped and placed in a cooler.
- Chemicals samples were collected manually in a one liter container that was immersed in the lake (LR-11 - LR-20) or the force main effluent (LR-21). The samples were divided among sampling bottles by means of a *cone splitter.* The cone splitter was used to insure an even distribution of the sample, both quantitatively and qualitatively, from the one liter container to the color-coded bottles that indicated the desired analysis. The cone splitter had ten hoses through which samples were dispensed. One hose was placed into each of the four color-coded 125 ml bottles and two hoses were placed in the the filter apparatus for the sample that required filtering before decanting into the 125 ml color-coded bottle. The four remaining hoses were drained to waste. The samples were capped and placed into a cooler until delivered to the laboratories.
- The cone splitter was rinsed with distilled water after each one liter sample was passed through it. The one liter sampling container was rinsed twice with lake water at the sampling site before the sample was collected. The probes from the field instruments were rinsed with distilled water between samples.
- All analyses were performed by the Suffolk County Department of Health Services Laboratories in Hauppauge, New York. The analytical methods used to analyze these selected parameters are described in Table 4-11.

4.2.3.2 Sampling Schedule. The wet weather sampling schedule was dependent upon the natural occurrence of rainfall. Samples were usually taken during the latter stages of a rainfall or the morning following a night rainfall. One series of samples was taken during the early stages of a rainfall event. A rainfall of at least 0.25 inches was considered the minimum amount required for collecting samples. As shown on Table 4-12, the wet weather stations were sampled during or following thirteen rain events from March 1983 through October 1984.

4.2.4 Analysis of Data. Bacterial analyses were completed for all thirteen rain events, and inorganic chemical analyses were done for eleven of the rain events. The complete series of inorganic chemical analyses were not always performed for each rainfall event sampled or for each sampling station.

Table 4-10
Suffolk County Department of Health Services
Sampling Parameters and Color Coding for Sampling Bottles

TAPE COLOR	PARAMETER	QUANTITY OF SAMPLE
Red	TKN TP	125 ml
Green	NO_3-N NO_2-N NH_3-N	125 ml
White*	DKN DP	125 ml
Beige	Chloride	125 ml
---	Bacteriological**	

* Sample Filtered
** Total Coliform MPN/100 ml
Fecal Coliform MPN/100 ml

4.2.4.1 Bacterial Analysis. Bacterial samples were collected to determine the concentrations of total coliform and fecal coliform bacteria at the 11 sampling sites (Tables 4-13 and 4-14). These tables also indicate the geometric mean concentration of all samples over the course of the sampling program at each site, as well as the geometric mean of the ten lake sites for each sampling event.

Table 4-15 presents the ratios of fecal to total coliform for each sampling station. The fecal coliform to total coliform ratios range from 0.11 to 0.30 for the eleven sampling sites. This indicates that a large portion of the coliform population was non-fecal in origin. A possible explanation is that a large portion of the bacteria are soil bacteria that were carried along with solid material in runoff. However, caution should be applied when interpreting the data. The use of ratios is most appropriate for water samples collected as soon as possible near the source of contamination. Bacterial concentrations can change depending upon the conditions to which they are exposed. Some of these conditions include elapsed time, ambient temperature, dilution and the settling of suspended solids to which bacteria may adhere. Time spent in transit is important because of the different die-off rates of bacterial species.

Bacterial concentrations tended to be highest during the warm weather months and lowest during cold weather months. Table 4-16 presents a comparison of total coliform and fecal coliform concentrations during warm and cold weather periods. Although the concentrations were significantly lower during cold weather periods, the fecal coliform to total coliform ratios remained fairly constant.

A review of the sampling results from the eleven sampling sites underscores the fact that the sites are subject to different influences. The most obvious example is sampling site LR-21, which is the only site that is not a lake station. The samples collected at this site were taken from the force main discharge from three interconected recharge basins located about one-half mile to the north. These three recharge basins collect runoff from the surrounding medium density residential area. Tables 4-13 and 4-14 show that samples from site LR-21 have the highest geometric mean for both total coliforms and fecal coliforms of all eleven sampling sites. These results were expected because the samples at site LR-21 are from runoff while the others are lake water samples. However, the data from site LR-21 represent only one sample per rain event at only one point in time along the entire storm hydrograph. From these data it was impossible to determine the impact upon runoff water quality caused by the intermediate storage in the recharge basins.

Table 4-11
Analytical Procedures For Chemical and Bacterial Water Quality Analysis

PARAMETER	CHEMICAL ANALYTICAL PROCEDURE REFERENCE
NO_3 & NO_2	Technicon Autoanalyzer II Method (Cu/Cd Reduction, Diazotized, Sulfanilamide, Coupled with Napthylethylene Diamine Dihydrochloride)
NH_3	EPA Method 353.2 (Colorimetric, Automated, Cadmium Reduction)
TKN & DKN	EPA Method 351.1 (Chlorimetric Semi-Automated Phenate) Modified Sulfuric-Persulfate Digestion to Convert to Ammonia
Total Phosphate	EPA Method 365.1 (Colorimetric, Semi-Automated Ascorbic Acid) Modified Sulfuric-Persulfate Digestion to Convert to Orthophosphate
Dissolved Phosphate Ortho-Phosphate	EPA Method 365.2 (Colorimetric, Ascorbic Acid)
TOC	EPA Method 415.1 (Combustion or Oxidation)
TSS	Standard Method 209C (Gravimetric)
Cl	EPA Method 325.2 (Automatic Ferricyanide)
Cu	EPA Method 220.1 (Atomic Adsorption Spectrometric Method)
Fe	EPA Method 236.1 (Atomic Adsorption Spectrometric Method)
Mn	EPA Method 243.1 (Atomic Adsorption Spectrometric Method)
Cr	EPA Method 218.1 (Atomic Adsorption Spectrometric Method)
Ni	EPA Method 249.1 (Atomic Adsorption Spectrometric Method)
Zn	EPA Method 289.1 (Atomic Adsorption Spectrometric Method)
Pb	EPA Method 239.1 (Atomic Adsorption Spectrometric Method)
Cd	EPA Method 213.1 (Atomic Adsorption Spectrometric Method)

PARAMETER	BACTERIAL ANALYTICAL PROCEDURE REFERENCE
Coliforms (Fecal)	MPN Procedure; Std. Methods, Method 908C
Coliforms (Total)	MPN Procedure; Std. Methods, Method 908A
Fecal Streptococci	Membrane Filter Procedure; Std. Methods, Method 910B

Table 4-12
Wet Weather Sampling Events

DATE	PRECIPITATION (INCHES)	TIME OF SAMPLES COLLECTION
3/2/83	0.51	3 Hours After Rainfall
4/11/83	3.78	14 Hours After Rainfall
5/16/83	1.36	During Rainfall
6/29/83	0.74	8 Hours After Rainfall
9/30/83	0.28	During Rainfall
10/13/83	0.77	14 Hours After Rainfall
10/19/83	0.63	2 Hours After Rainfall
11/29/83	0.66	4 Hours After Rainfall
12/6/83	0.50	Beginning of Rainfall
3/22/84	0.40	21 Hours After Rainfall
5/30/84	3.97	During Rainfall
7/18/84	0.56	During Rainfall
10/24/84	0.37	15 Hours After Rainfall

Factors that would tend to reduce the bacterial concentrations in the discharge collected at site LR-21 are the retention time as the runoff travels through the recharge basins, settling or sedimentation, the dilution of the runoff with water already retained in the recharge basin from prior storms and possibly dilution from groundwater that may seep into the recharge basin. A more detailed study of the three recharge basin system is required to gain a better understanding of whether any partial treatment of runoff actually occurs.

Of the ten lake stations, site LR-11 had the highest geometric mean concentrations for total coliform and fecal coliform, although higher bacterial counts for individual sampling events were often found at other stations. Site LR-11 is on the north side of Lake Ronkonkoma where the stream from the bog travels south through a culvert under Smithtown Boulevard and enters the lake water. The bacterial quality of water from this bog may be affected by waterfowl and other animals inhabiting the bog, failing on-lot sewage systems, direct runoff from Smithtown Boulevard, and discharge from three recharge basins entering the bog at site LR-21.

The remaining nine lake sampling locations, LR-12 through LR-20, had geometric mean bacterial concentrations that ranged from 537 to 2570 MPN/100 ml for total coliforms and from 166 to 389 MPN/100 ml for fecal coliforms.

There were sizable fluctuations in bacterial concentrations reported for each station, depending upon the date the samples were collected, and among all the stations on the same sampling dates. Nevertheless, the data for all stations generally demonstrate the elevated bacterial concentrations that can be expected during wet weather conditions.

4.2.4.2 Chemical Analyses. Tables 4-17 through 4-24 contain the data for the chemical parameters TKN, DKN, NH_3-N, NO_3-N, NO_2-N, TP, DP and chloride selected for this sampling program. Analyses were not performed for all of the parameters for every sampling event. The most complete data were obtained for chloride and for the portion of the nitrogen series consisting of NH_3-N, NO_2-N and NO_3-N.

In comparing the nitrogen samples among the eleven sampling stations, the anticipated difference in concentration between site LR-21 and the other ten sites is quite evident. As in the case of the bacterial parameters, the samples taken at station LR-11 and analyzed for NH_3-N

Table 4-13
Lake Water Quality during Wet Weather Conditions
Total Coliform (MPN/100ml)

SAMPLING DATE	LR-11	LR-12	LR-13	LR-14	LR-15	LR-16	LR-17	LR-18	LR-19	LR-20	LR-21	GEOMETRIC MEAN LR-11 - LR-20*
	SAMPLING STATION NUMBER											
3/2/83	430	230	430	430	430	750	230	430	230	2,400	NS	447
4/11/83	11,000	2,400	1,500	2,400	430	430	40	430	430	90	NS	646
5/16/83	9,300	24,000	24,000	46,000	4,300	24,000	9,300	46,000	24,000	430	NS	12,589
6/29/83	2,100	4,600	930	2,400	930	24,000	930	2,400	930	430	NS	1,820
9/30/83	4,600	15,000	1,500	1,500	2,400	11,000	2,100	11,000	930	430	NS	2,884
10/13/83	46,000	240	4,600	4,600	11,000	4,600	4,600	46,000	3,900	2,400	46,000	5,433
10/19/83	2,400	4,600	750	2,400	430	230	430	430	930	230	24,000	773
11/29/83	9,300	430	430	2,400	4,600	2,400	430	430	230	230	2,400	918
12/6/83	4,600	430	230	2,400	4,600	430	430	11,000	430	430	430	1,059
3/22/84	430	430	150	90	90	40	90	<30	90	<30	150	96
5/30/84	24,000	2,400	24,000	110,000	390	930	930	230	930	1,500	46,000	2,642
7/18/84	11,000	230	230	930	110,000	430	230	430	930	4,600	≥240,000	1,265
10/24/84	1,500	430	2,400	2,400	230	NS	750	2,400	930	1,500	15,000	845
GEOMETRIC MEAN	4,571	1,259	1,230	2,570	1,479	1,349	575	1,230	794	537	8,511	

NS=No Sample

* LR-21 not included because it is not a lake station.

Table 4-14
Lake Water Quality during Wet Weather Conditions
Fecal Coliform (MPN/100ml)

SAMPLING DATE	LR-11	LR-12	LR-13	LR-14	LR-15	LR-16	LR-17	LR-18	LR-19	LR-20	LR-21	GEOMETRIC MEAN LR-11 - LR-20*
	SAMPLING STATION NUMBER											
3/2/83	90	40	230	230	90	750	90	230	230	930	NS	186
4/11/83	4,600	430	930	90	90	<30	<30	230	40	<30	NS	141
5/16/83	1,500	4,300	2,400	24,000	1,500	4,300	930	4,300	4,300	230	NS	2,512
6/29/83	430	2,400	230	90	40	2,400	230	930	230	230	NS	347
9/30/83	4,600	2,400	430	930	230	11,000	230	930	430	230	NS	392
10/13/83	7,500	240	1,500	2,400	930	1,500	230	2,400	230	930	1,500	802
10/19/83	430	750	110	230	230	230	90	230	430	230	24,000	247
11/29/83	90	230	430	430	930	230	230	230	40	40	90	191
12/6/83	930	230	230	230	4,600	430	430	2,400	230	150	230	489
3/22/84	<30	40	<30	<30	<30	40	40	<30	<30	<30	40	32
5/30/84	2,400	210	430	3,900	<30	40	210	90	150	40	4,300	254
7/18/84	230	<30	<30	30	15,000	70	40	<30	90	430	9,300	112
10/24/84	930	230	430	430	90	NS	750	430	930	430	4,300	427
GEOMETRIC MEAN	661	324	295	380	295	389	166	363	204	170	912	

NS=No Sample

* LR-21 not included because it is not a lake station.

Table 4-15
Ratios of Fecal Coliform/Tolal Coliform

SAMPLING SITE	FECAL COLIFORM/TOTAL COLIFORM
LR-11	0.15
LR-12	0.26
LR-13	0.24
LR-14	0.15
LR-15	0.20
LR-16	0.29
LR-17	0.29
LR-18	0.30
LR-19	0.26
LR-20	0.21
LR-21	0.11

Table 4-16
Warm Weather and Cold Weather Bacterial Concentrations

BACTERIAL PARAMETER	WARM WEATHER GEOMETRIC MEAN (MPN/100 ml)	COLD WEATHER GEOMETRIC MEAN (MPN/100 ml)	WARM WEATHER/ COLD WEATHER RATIO
Total Coliform	2754	490	5.6/1
Fecal Coliform	692	148	4.7/1
FC/TC Ratio	0.25	0.30	---

Weather = May-October

Cold Weather = November-April

and NO_3-N had the highest mean concentrations of all ten lake stations. The NO_2-N data indicated that this form of nitrogen was found in much lower concentrations than either the NO_3-N or the NH_3-N. This is very common because nitrite is unstable and easily oxidized to the nitrate form. Nitrite is an intermediate form between NH_3-N and NO_3-N in the process of stabilization via the oxidation process and seldom exceeds 0.1 mgl in surface water or groundwater. A comparison of the NH_3-N data with the total Kjeldahl nitrogen (TKN) data also provides some insight. TKN represesnts the total of ammonia-nitrogen and organic nitrogen. It can be seen that at station LR-21 the ammonia constitutent accounts for most of the TKN whereas, at the ten lake stations, the organic nitrogen component acccounts for a much higher percentage of the TKN. There are no discernible trends among the chloride and phosphate data from the eleven sampling locations. The range of concentration is much smaller than that observed in the nitrogen series, and data from some of the sampling locations around the lake indicated higher concentrations than those found at station LR-21.

In summary, a review of the data for the chemical analyses leads to the following findings. Significantly higher concentrations of NH_3-N and NO_3-N were detected at station LR-21 than at the ten sampling locations around the perimeter of the lake. Among the ten lake stations, site LR-11, which is at the interface of the lake and the stream from the bog north of the lake, displayed the highest concentrations of NH_3-N and NO_3-N. A comparison of the NH_3-N and TKN data indicated that a large part of the nitrogen in the lake was in the form of organic nitrogen, while the discharge from the recharge basins to the bog contained little organic nitrogen.

Table 4-17
Lake Water Quality during Wet Weather Conditions
Total Kjeldahl Nitrogen (mg/l)

SAMPLING DATE	LR-11	LR-12	LR-13	LR-14	LR-15	LR-16	LR-17	LR-18	LR-19	LR-20	LR-21	MEAN LR-11 -LR-20*
						—SAMPLING STATION NUMBER—						
3/2/83	0.8	0.5	0.6	0.7	0.6	0.5	0.6	0.7	0.6	0.5	NS	0.6
4/11/83	0.5	0.8	0.4	0.6	0.3	0.4	0.4	0.4	0.4	0.7	NS	0.5
5/16/83	1.2	NS	0.4	NS	0.4	NS	0.8	NS	0.6	NS	NS	0.7
10/13/83	0.8	1.5	0.9	0.4	0.8	0.7	0.8	0.5	1.0	0.8	0.4	0.8
12/6/83	0.8	0.8	NS	NS	0.9	0.5	NS	NS	NS	NS	0.8	0.8
5/30/84	1.1	0.6	0.5	0.7	0.9	0.4	0.3	0.9	0.4	1.2	1.5	0.7
7/18/84	1.0	0.9	1.0	0.6	0.7	0.9	0.7	0.9	0.8	0.8	2.7	0.8
MEAN	0.9	0.8	0.6	0.6	0.7	0.6	0.6	0.7	0.6	0.8	1.4	

NS = No Sample
* LR-21 not included because it is not a lake station.

Table 4-18
Lake Water Quality During Wet Weather Conditions
Dissolved Kjeldahl Nitrogen (mg/l)

SAMPLING DATE	LR-11	LR-12	LR-13	LR-14	LR-15	LR-16	LR-17	LR-18	LR-19	LR-20	LR-21	MEAN LR-11 - LR-20*
						—SAMPLING STATION NUMBER—						
3/2/83	0.6	0.4	0.5	0.5	0.6	0.6	0.4	0.6	0.8	0.8		
5/16/83	0.9	NS	0.5	NS	0.5	NS	0.3	NS	0.3	NS	NS	0.5
10/13/83	0.6	0.6	0.3	0.3	0.8	0.6	0.6	0.3	1.0	0.4	0.4	0.6
12/6/83	0.7	0.8	NS	NS	NS	0.5	NS	NS	NS	NS	0.7	0.7
5/30/84	1.2	0.4	0.4	0.4	0.6	0.3	0.6	0.4	0.4	1.1	1.2	0.6
7/18/84	0.9	0.8	1.0	0.6	NS	0.8	0.7	0.7	0.7	0.7		
MEAN	0.8	0.6	0.5	0.5	0.6	0.6	0.5	0.5	0.6	0.8	1.3	

NS = No Sample
* LR-21 not included because it is not a lake station.

Table 4-19
Lake Water Quality During Wet Weather Conditions
NH_3-N (mg/l)

SAMPLING DATE	—SAMPLING STATION NUMBER— LR-11	LR-12	LR-13	LR-14	LR-15	LR-16	LR-17	LR-18	LR-19	LR-20	LR-21	MEAN LR-11 - LR-20*
3/2/83	0.70	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.30	0.20	NS	0.26
4/11/83	0.21	0.19	0.08	0.08	0.05	0.05	0.05	0.05	0.09	<0.05	NS	0.09
5/16/83	0.48	0.06	0.05	0.26	0.05	0.06	0.05	0.11	0.07	0.07	NS	0.13
10/13/83	0.91	0.40	0.38	0.37	0.40	0.39	0.40	0.30	0.37	0.36	0.30	0.43
10/19/83	0.83	0.27	2.20	0.28	0.22	1.00	0.26	0.27	0.28	0.33	0.14	0.59
11/29/83	0.70	0.40	0.39	0.38	0.39	0.40	0.40	0.40	0.38	0.40	0.70	0.42
12/6/83	0.93	0.43	0.40	0.13	0.14	0.41	0.40	0.20	0.41	0.42	1.00	0.39
3/22/84	0.26	0.10	0.09	0.09	0.08	0.09	0.09	0.07	0.07	0.07	3.30	0.10
5/30/84	0.78	0.10	0.09	0.10	0.12	0.16	0.11	0.11	0.10	0.13	1.10	0.17
7/18/84	0.31	0.18	0.22	0.16	0.09	0.18	0.18	0.19	0.17	0.19	2.30	0.19
10/24/84	0.43	0.36	0.37	0.36	0.35	NS	0.36	0.36	0.37	0.36	1.10	0.37
MEAN	0.60	0.24	0.41	0.22	0.19	0.29	0.23	0.21	0.24	0.23	1.25	

NS = No Sample
* LR-21 not included because it is not a lake station.

Table 4-20
Lake Water Quality During Wet Weather Conditions
NO_3-N (mg/l)

SAMPLING DATE	—SAMPLING STATION NUMBER— LR-11	LR-12	LR-13	LR-14	LR-15	LR-16	LR-17	LR-18	LR-19	LR-20	LR-21	MEAN LR-11 - LR-20*
3/2/83	1.70	0.30	0.20	0.20	<0.20	<0.20	0.20	0.20	0.20	<0.20	NS	0.36
4/11/83	0.42	0.45	0.32	0.31	0.33	0.33	0.33	0.32	0.32	0.33	NS	0.38
5/16/83	0.70	0.22	0.20	0.39	0.20	0.19	0.19	0.14	0.19	0.20	NS	0.26
10/13/83	0.46	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.52	0.09
10/19/83	0.45	<0.05	1.50	<0.05	<0.05	0.95	<0.05	<0.05	<0.05	<0.05	0.44	0.33
11/29/83	0.52	0.10	0.09	0.09	0.09	0.09	0.08	0.09	0.10	0.09	0.72	0.13
12/6/83	0.75	0.23	0.14	0.05	0.44	0.08	0.09	0.14	0.10	0.10	0.95	0.21
3/22/84	0.64	0.33	0.25	0.24	0.25	0.26	0.25	0.24	0.24	0.23	2.60	0.29
5/30/84	0.10	0.22	0.20	0.15	0.20	0.22	0.19	0.18	0.09	0.19	1.10	0.17
7/18/84	0.09	<0.05	<0.05	<0.05	0.34	<0.05	<0.05	<0.05	<0.05	<0.05	1.00	0.08
10/24/84	0.07	<0.05	<0.05	<0.05	<0.05	NS	<0.05	<0.05	<0.05	<0.05	3.00	0.05
MEAN	0.53	0.19	0.28	0.15	0.20	0.24	0.14	0.14	0.13	0.14	1.29	

NS = No Sample
* LR-21 not included because it is not a lake station.

Table 4-21
Lake Water Quality During Wet Weather Conditions
NO_2-N (mg/l)

—SAMPLING STATION NUMBER—

SAMPLING DATE	LR-11	LR-12	LR-13	LR-14	LR-15	LR-16	LR-17	LR-18	LR-19	LR-20	LR-21	MEAN LR-11 - LR-20*
3/2/83	0.020	0.007	0.007	0.007	0.007	0.007	0.007	0.008	0.010	0.008	NS	0.009
4/11/83	0.007	0.007	0.006	0.006	0.005	0.005	0.005	0.005	0.005	0.004	NS	0.006
5/16/83	0.022	0.007	0.007	0.033	0.005	0.007	0.005	0.006	0.006	0.005	NS	0.010
10/13/83	0.021	0.004	0.004	0.006	0.004	0.003	0.003	0.006	0.004	0.003	0.021	0.006
10/19/83	0.018	0.002	0.041	0.002	0.001	0.021	0.001	0.002	0.003	0.002	0.013	0.009
11/29/83	0.012	0.006	0.006	0.007	0.006	0.006	0.006	0.006	0.008	0.006	0.021	0.007
12/6/83	0.013	0.016	0.008	0.008	0.023	0.008	0.009	0.009	0.009	0.008	0.024	0.011
3/22/84	0.009	0.005	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.027	0.005
5/30/84	0.014	0.008	0.003	0.008	0.009	0.009	0.008	0.010	0.007	0.009	0.017	0.009
7/18/84	0.003	0.002	0.002	0.002	0.020	0.002	0.004	0.002	0.002	0.002	0.029	0.004
10/24/84	0.007	0.004	0.004	0.004	0.004	NS	0.003	0.004	0.006	0.004	0.041	0.004
MEAN	0.013	0.006	0.009	0.008	0.008	0.007	0.005	0.006	0.006	0.005	0.024	

NS=No Sample
* LR-21 not included because it is not a lake station.

Table 4-22
Lake Water Quality During Wet Weather Conditions
Total Phosphorus (mg/l)

—SAMPLING STATION NUMBER—

SAMPLING DATE	LR-11	LR-12	LR-13	LR-14	LR-15	LR-16	LR-17	LR-18	LR-19	LR-20	LR-21	MEAN LR-11 - LR-20*
3/2/83	0.021	0.016	0.023	0.020	0.024	0.026	0.024	0.017	0.021	0.015	NS	0.021
4/11/83	0.041	0.066	0.059	0.062	0.038	0.033	0.036	0.048	0.038	0.022	NS	0.044
5/16/83	0.067	NS	0.068	NS	0.026	NS	0.044	NS	0.035	NS	NS	0.048
10/13/83	0.051	0.042	0.037	0.032	0.087	0.038	0.038	0.064	0.029	0.030	0.071	0.045
12/6/83	0.046	0.054	NS	NS	0.500	0.043	NS	NS	NS	NS	0.032	0.161
5/30/84	0.075	0.109	0.042	0.040	0.045	0.038	0.027	0.051	0.037	0.055	0.037	0.052
7/18/84	0.068	0.014	0.052	0.019	0.221	0.050	0.019	0.038	0.026	0.018	0.036	0.053
Mean	0.053	0.050	0.047	0.035	0.134	0.038	0.031	0.044	0.031	0.028	0.044	

NS=No Sample
* LR-21 not included because it is not a lake station.

Table 4-23
Lake Water Quality During Wet Weather Conditions
Dissolved Phosphorus (mg/l)

SAMPLING DATE	—SAMPLING STATION NUMBER— LR-11	LR-12	LR-13	LR-14	LR-15	LR-16	LR-17	LR-18	LR-19	LR-20	LR-21	MEAN LR-11 - LR-20*
3/2/83	0.010	0.015	0.018	0.014	0.021	0.022	0.021	0.016	0.018	0.016	NS	0.016
5/16/83	0.035	NS	0.036	NS	0.009	NS	0.013	NS	0.019	NS	NS	0.022
10/13/83	0.029	0.025	0.012	0.015	0.069	0.014	0.016	0.036	0.014	0.014	0.037	0.024
12/6/83	0.043	0.053	NS	NS	NS	0.013	NS	NS	NS	NS	0.024	0.036
5/30/84	0.036	0.023	0.018	0.021	0.011	0.015	0.043	0.022	0.019	0.019	0.016	0.023
7/18/84	0.029	0.014	0.046	0.016	NS	0.025	0.021	0.009	0.023	0.007	0.016	0.019
MEAN	0.030	0.026	0.026	0.017	0.028	0.018	0.023	0.021	0.019	0.014	0.023	

NS=*o Sample
* LR-21 not included because it is not a lake station.

Table 4-24
Lake Water Quality During Wet Weather Conditions
Chloride (mg/l)

SAMPLING DATE	—SAMPLING STATION NUMBER— LR-11	LR-12	LR-13	LR-14	LR-15	LR-16	LR-17	LR-18	LR-19	LR-20	LR-21	MEAN LR-11 -LR-20*
3/2/83	26	25	25	25	26	25	25	25	29	26	NS	25.7
4/11/83	12	20	21	21	23	24	23	23	24	23	NS	21.4
5/16/83	26	20	17	14	21	16	20	6	20	21	NS	18.1
10/13/83	28	23	22	22	22	22	22	15	22	22	17	22.1
10/19/83	29	24	30	24	24	29	24	24	24	24	13	25.6
11/29/83	35	23	23	22	22	22	22	22	22	22	12	23.5
3/22/84	25	22	21	22	21	21	22	22	21	22	35	21.9
5/30/84	25	22	20	17	20	20	21	20	15	18	13	19.8
7/18/84	21	22	22	21	3	21	22	22	22	21	26	19.7
10/24/84	22	21	21	21	20	NS	21	21	21	21	22	21.2
Mean	24.9	22.2	22.2	20.9	20.2	22.2	22.2	20.0	22.0	22.0	19.7	

NS=No Sample
* LR-21 not included because it is not a lake station.

4.3 STORMWATER RUNOFF SURVEY

4.3.1 Introduction This section describes the sampling program conducted by the SCDHS to assess the quality of stormwater runoff entering the lake. The sampling took place at the outlet of the storm drain that discharges into the southeastern portion of the lake. Estimates of runoff quality for selected parameters, together with the estimated area of the watershed were then used to calculate the total pollutant load contributed by runoff to the lake (Chapter 6).

4.3.2 Site Description The site selected for stormwater runoff sampling was the outlet of 28" x 45" oval corrugated metal pipe (CMP) storm drain that discharges into the southeastern portion of the lake. While sampling the lake during rainfall conditions, it was noticed that among all the storm sewer pipes discharging into the lake, this pipe provided the largest volume of runoff to the lake. The storm sewer outlet pipe is adjacent to the north side of Brookhaven Town Beach, and stormwater discharged from it flows over a concrete sluiceway, approximately 30 feet long, before entering Lake Ronkonkoma. The storm drain serves a thirty acre drainage area composed primarily of medium density residential land (Figure 4-11). There are moderate slopes within this drainage area. Most of the runoff travels along the surface of the roadways until intercepted by drains near the intersection of Lake Terrace and Lake Shore Road.

4.3.3 Sampling Program Stormwater runoff samples were collected from the effluent of the 28" x 45" oval CMP before it was discharged onto the concrete sluiceway that channeled the runoff into Lake Ronkonkoma. A flow meter, installed inside this pipe, measured the entire volume of runoff from the 30 acre site. The sampling equipment and procedures were as indicated below.

4.3.3.1 Equipment Precipitation was measured by a manual dipstick gauge, which was set up at the sampling site by the sampling team. The gauge was read several times throughout the duration of the storm and prior to the collection of a runoff sample to provide data on the storm intensity and total precipitation. A recording precipitation gauge was installed on the roof at the SCDHS garage in Hauppauge to obtain daily precipitation data. A precipitation sample was collected in two plastic buckets placed adjacent to the sampling site. The precipitation sample was analyzed for the same chemical parameters as the runoff samples.

A Marsh-McBirney Velocity Modified Flow Meter, Model 265, was used to measure the volume of stormwater runoff discharged into Lake Ronkonkoma from the 28" x 45" oval CMP. This flow meter recorded flow, in millions of gallons per day as a function of time, on a 24-hour circular chart. The meter also measured flow in increments of one thousand gallons on a separate digital totalizer. The probe of the flow meter was installed and checked in accordance with the procedure recommended in the Marsh-McBirney operations manual. Manufacturer's guidance for upstream and downstream conditions was observed.

Portable instruments were used to measure pH, conductivity and water temperature. These parameters were recorded in the field at the time of sampling.

4.3.3.2 Procedures Stormwater runoff samples were analyzed for bacteriological and chemical parameters as shown in Table 4-25. The first sample was collected when the digital totalizer registered 1,000 gallons of runoff. This was done to determine the significance, if any, of the *First Flush* from the runoff. The second sample was taken at the 5,000 gallon mark. Subsequent samples were taken at each 5,000 gallon interval or multiple thereof, depending upon the intensity and duration of the storm. It was standard procedure to collect a sample at least once every 60 minutes for storms of extended duration. If more samples were collected than it was feasible to analyze, then individual samples were selected that would represent the entire hydrograph as closely as possible.

Dual or replicate samples were taken once during each storm event. This procedure was done to indicate any variability between simultaneous grab samples.

Bacterial samples were collected manually by immersing a sterile container into the runoff flow, then capping it and placing it on ice in a cooler. These samples were analyzed for total coliforms, fecal coliforms and fecal streptococci within 12 hours of collection.

Table 4-25
Suffolk County Department of Health Services
Sampling Parameters and Color Coding for Sampling Bottles

TAPE COLOR	PARAMETER	QUANTITY OF SAMPLE
Red	TKN TP	125 ml
Green	NO_3-N NO_2-N NH_3-N	125 ml
White	DKN DP	125 ml
Beige	Chloride Suspended Solids	250 ml
Orange	Total Metals*	125 ml
---	Bacteriological**	

* Total Metals - copper, iron, manganese, chromium, nickel, lead and cadmium.
** Bacteriological - total coliform, fecal coliform, fecal strep.

Chemical samples were collected manually in a one liter container that was immersed in the runoff flow and then dispensed into sampling bottles through a *cone splitter*. The procedures using the cone splitter are the same as those previously described. The only difference is that the runoff sampling program also included analyses for total suspended solids, total carbon and heavy metals. The color coding for bottles used to collect the additional samples is indicated in Table 4-25.

All analyses were performed by the Suffolk County Department of Health Services - Public Health Laboratory in Hauppauge, New York. The analytical methods used are indicated in Table 4-25 of this report. Runoff samples were analyzed as grab samples and the results were used to calculate the Event Mean Concentration (EMC). The formula used to calculate the EMC is provided in the Appendix C of this report.

4.3.4 Characteristics of the Runoff Hydrograph for the Study Area A total of three storm events were sampled to study runoff. It was intended that storm events would be sampled over the course of an 18-month period. However, the rising level of Lake Ronkonkoma during 1984 inundated the 28" x 45" oval CMP adjacent to Brookhaven Town Beach and eliminated the opportunity for sampling at this site. Once the rising lake waters started to flow into this pipe, it was no longer possible to install the flow meter and measure the volume of direct runoff being discharged. At the same time, runoff flowing through the pipe became mixed with lake water inside the pipe before it could be sampled, thus diluting the runoff sample.

Figure 4-12 shows a hydrograph of the runoff together with a corresponding hyetograph of the rainfall during a rainfall sampling event at the 30 acre site on 9/21/83 - 9/22/83. According to this diagram, the flow of the runoff responded rather quickly to the intensity of the rainfall. There was a lag period during the beginning of the storm as rainfall accumulated and began to flow towards the storm sewers. As the rainfall intensity increased, the hydrograph would rise and reach a peak within minutes following the most intense rainfall interval. Then, as the rain subsided, the flow dropped off rapidly and approached zero flow as the rain ended. This type of hydrograph, indicating a rapid response to rainfall conditions, is typical for small catchment areas (less than 100 acres) with sloping terrain.

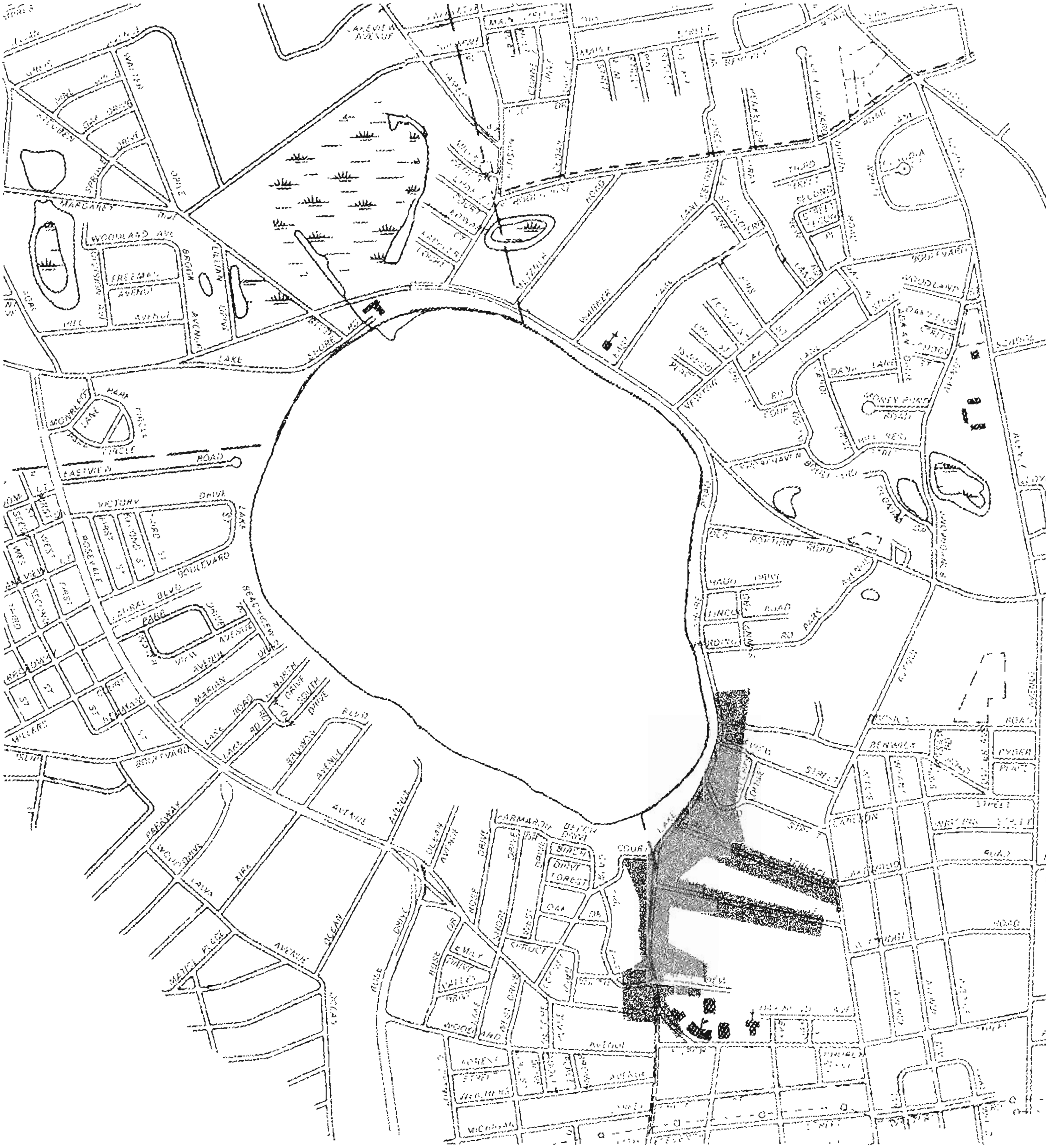


Figure 4-11
STORMWATER RUNOFF; SURFACE DRAINAGE CONTRIBUTARY AREA

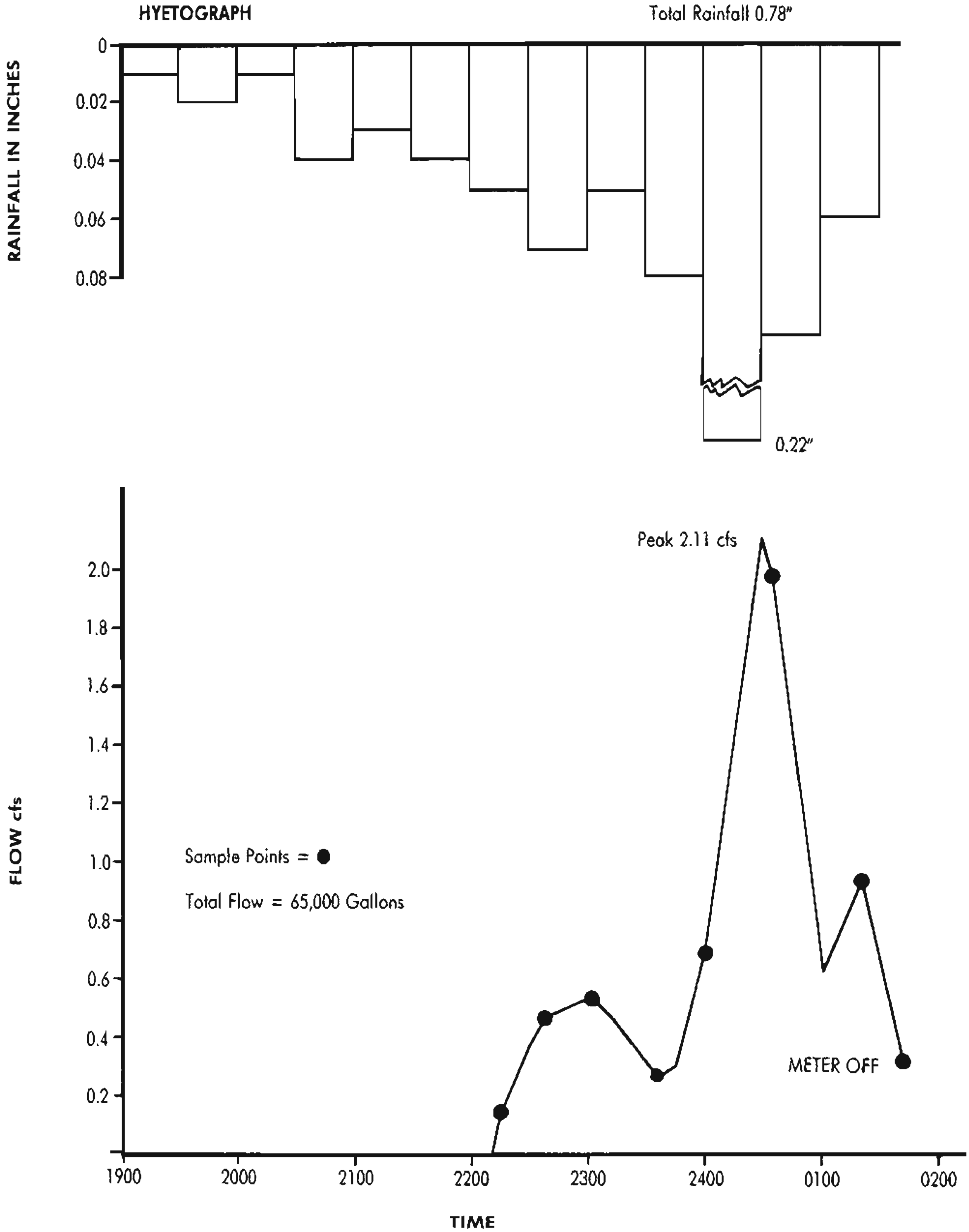


Figure 4-12
RUNOFF HYDROGRAPH
for the STUDY AREA

Within the 300 acres of the Lake Ronkonkoma watershed there are many small size catchment areas, such as the one just described, each with its own system of storm sewers that discharge runoff into the lake. Presumably, many stormwater runoff hydrographs for those areas would behave similarly to that for the 30 acre site described above. However, the volume of runoff would vary depending upon the size of the area, the slope of the terrain, and the land use.

4.3.5 Analysis of Data

4.3.5.1 Relationship of Runoff to Precipitation Table 4-26 presents a summary of the runoff and precipitation for the three rainfall events that were monitored at Lake Ronkonkoma. Since only three storms were monitored, it is difficult to use averages from these data to derive general conclusions concerning the characteristics of runoff in the watershed area. The first storm, monitored on 8/11/83, produced 3.25 inches of rainfall within three hours. Usually a storm of high intensity and a large volume of rainfall results in a higher runoff coefficient than smaller storms. However, as this storm was being monitored, the storm sewer became hydraulically overloaded, which resulted in a large portion of the runoff not being recorded.

A part of this undercounting of runoff volume can be attributed to the accumulation of runoff on Lake Shore Drive. Flooding conditions caused the runoff to bypass the drainage system and flow overland directly into the lake. The turbulent flow of runoff through the 28" x 45" CMP where the flow meter was installed also contributed to the error in flow measurement. The hydraulic overloading resulted in a flow of high velocity, extremely turbulent runoff through the pipe. Such a condition can cause false readings in the pressure transducer of the flow meter, resulting in the underestimation of the water level in the pipe and a lower recorded volume of flow.

Table 4-26
Relationship of Runoff to Precipitation

DATE	PRECIPITATION (inches)	PRECIPITATION (Gallons)	RUNOFF (inches)	RUNOFF (Gallons)	RUNOFF COEFFICIENT
8/11/83	3.25	2,647,350	0.23	191,000	0.072*
9/21/83	0.78	635,350	0.08	65,000	0.102
11/15/83	1.91	1,555,825	0.34	275,000	0.177

* Volume of runoff from this storm was undercounted due to hydraulic overloading of storm sewer system.

To obtain a broader base of information for determination of an appropriate runoff coefficient for the Lake Ronkonkoma area, a comparison was made with the runoff data from the Long Island Segment of the Nationwide Urban Runoff Program (NURP). As part of that study, the SCDHS compiled runoff data from 27 rain storms that it monitored in a medium density residential area in Deer Park, New York. The runoff coefficient for the three rain events studied at Lake Ronkonkoma fell within the range of the NURP data. However, the NURP data generally showed that as the volume and intensity of precipitation increase, there is usually a corresponding increase in the runoff coefficient.

For reasons already mentioned, the first storm studied at Lake Ronkonkoma had a very low runoff coefficient of 0.072. When this storm is eliminated from consideration, the average of the data for the other two storms yields a runoff coefficient of 0.14. This is still substantially lower than the average runoff coefficient of 0.236 for the 27 storms monitored by the SCDHS for NURP or the runoff coefficient of 0.30 estimated for the Holzmacher Study.[1]

[1] Suffolk County Department of Public Works, *Drainage Improvements Including Groundwater Relief Phase I - Feasibility Study, Capital Project No. 5013, Vol. 3 Solution to Flooding in the Vicinity of Lake Ronkonkoma*, Holzmacher, McLendon and Murrell, P.C.aH2M Corp., 1980. 16.11 p.

The SCDHS selected a runoff coefficient of 0.20 for the Lake Ronkonkoma watershed, since this value would take into account the lower runoff coefficient average of 0.14 from the two storms measured at Lake Ronkonkoma and adjust it upwards to reflect the more statistically reliable data developed in 27 storm events from the NURP study.

4.3.5.2 Bacterial Results. A primary consideration for sampling stormwater runoff into Lake Ronkonkoma was the need to determine the amount of bacteria entrained in the runoff. The stormwater runoff samples collected at Lake Ronkonkoma were analyzed for total coliform, fecal coliform and fecal streptococci bacteria. Tables 4-27, 4-28 and 4-29 show the concentrations that were found in each grab sample. The grab samples were used to calculate the Event Mean Concentrations (EMC's)[1] for the three storm events. The geometric mean of the bacterial concentrations in runoff from these storm events were compared with the geometric mean from the 27 storm events sampled by the SCDHS at a medium density residential neighborhood in Deer Park, New York, as part of the NURP study (Table 4-30). Due to the limited number of dilutions performed in the laboratory, the total coliforms and fecal coliforms concentrations at Lake Ronkonkoma on 8/13/83 were both recorded as >24,000 MPN/100 ml. Since the concentrations for these two categories of bacteria could have been greater by an order of magnitude or more than the lower limit values, these two bacterial parameters were only averaged from two events on 9/21/83 and 11/15/83. Thus, total coliform and fecal coliform geometric mean concentrations for Lake Ronkonkoma are from two storm events and the fecal streptococci geometric mean is from three storm events.

The NURP data include samples taken during cold and warm weather months; whereas, the Lake Ronkonkoma samples were collected only during warm or moderate weather in the months of August, September and November. Since bacterial concentrations in stormwater runoff exhibit a marked decrease during colder temperatures, it is not surprising that the Lake Ronkonkoma samples had high bacterial concentrations. To compensate for this disparity in seasonal sampling, the geometric mean of the EMC's from the NURP samples which were collected in the months of June through November are included in Table 4-30. As seen from these selected data, the values are much closer when comparisons are limited to samples obtained during the same seasons.

In view of these comparisons, the SCDHS decided that the EMC's developed from the NURP data would be applied in calculating the total bacterial load for the entire 300 acres of the Lake Ronkonkoma watershed. These calculations are included in the presentation of all pollutant load inputs to the Lake (Chapter 6).

Table 4-30 also includes the ratios of fecal coliforms to total coliforms and fecal coliforms to fecal streptococci. The FC/TC ratio indicate that the majority of coliform are non-fecal in origin. These non-fecal coliforms may be soil bacteria from the lawns, gardens and wooded lots of the catchment area.

The FC/FS ratio was 0.189 for the Lake Ronkonkoma data. This compares favorably with the 0.200 for the overall NURP data and is somewhat lower than the 0.361 warm weather ratio from the NURP data. A ratio below 0.7 indicates that fecal pollution is derived from warm-blooded animals, other than humans. As cautioned in the NURP study, the FC/FS ratio was significantly higher than the FC/FS - 0.002 for dog feces cited in the Long Island 208 Study. Therefore, it is possible that there are other sources of fecal coliforms present that might account for the higher ration.

4.3.5.3 Chemical Results. The results of the chemical analyses of the runoff sampling are also presented in Tables 4-27,4-28 and 4-29. As with the bacterial samples, the laboratory analyses were performed on individual grab samples, and the results were used to calculate EMC's for each parameter. These EMC's were then averaged to provide a single EMC value for each chemical parameter sampled from the 30 acre watershed.

[1] The Event Mean Concentration (EMC), defined as the total constituent mass discharge divided by the total runoff volume, was developed and chosen as the primary water quality statistic during the NURP study.

Table 4-27
Stormwater Runoff Sampling (8-11-83)

TOTAL RAINFALL = 3.25 inches DURATION = 2.75 hours

Sample No.	Gallons of Runoff	Total Coliform MPN/100ml	Fecal Coliform MPN/100ml	Fecal Strep. FS/100ml	Cl mg/l	TC mg/l	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	TKN mg/l	DKN mg/l	TP mg/l	DP mg/l	TSS mg/l	pH	Temp. °C	Cond. μmho
1	1,000	≥24,000	≥24,000	72,000	6.0	20	1.70	.018	.51	5.0	2.1	1.000	.325	536	5.6	24	95
2	5,000	≥24,000	≥24,000	70,000	4.4	18	1.80	.018	.60	4.0	1.9	.797	.302	464	5.9	24	92
3	10,000	≥24,000	≥24,000	68,000	3.3	17	1.70	.019	.62	2.8	1.6	.549	.264	212	5.7	24	85
4	15,000	≥24,000	≥24,000	92,000	2.4	12	1.40	.017	.57	2.0	1.3	.379	.181	175	5.8	24	72
5*	15,000	≥24,000	≥24,000	110,000	2.9	13	1.40	.019	.77	2.8	1.6	.462	.201	174	5.8	24	72
6	25,000	≥24,000	≥24,000	110,000	3.3	11	0.90	.018	.50	4.7	1.5	1.090	.169	631	5.5	23	50
7	50,000	≥24,000	≥24,000	180,000	1.6	8	0.43	.007	.25	5.4	1.2	.436	.235	791	5.8	23	30
8	85,000	≥24,000	≥24,000	110,000	1.0	5	0.15	.006	.06	3.7	0.4	.964	.144	685	5.7	22	14
9	150,000	≥24,000	≥24,000	91,000	0.6	4	0.06	.005	<.05	1.2	0.3	.391	.097	262	5.8	21	11
10	180,000	≥24,000	≥24,000	61,000	0.7	5	0.09	.004	<.05	1.0	0.6	.210	.189	130	5.9	21	16
11	190,000	≥24,000	≥24,000	84,000	5.0	7	0.24	.012	.13	1.4	1.0	.280	.221	67	6.1	21	45
EVENT MEAN CONCENTRATION																	
		≥24,000	≥24,000	107,000	1.37	6.68	0.37	.008	.175	2.77	.72	.56	.16	435			
RAINWATER CHEMICAL ANALYSES																	
					<.5	3	.19	.002	.20	.6	.3	.015	.004				

METAL COMPOSITE:	RUNOFF (mg/l)	RAINWATER (mg/l)
Cu	<.02	<.02
Fe	2.00	.07
Mn	.19	.04
Cr	<.02	<.02
Ni	<.10	<.10
Zn	.20	<.10
Pb	.20	<.20
Cd	<.20	<.02

*Replicate

Table 4-28
Stormwater Runoff Sampling (9-21/22-83)

TOTAL RAINFALL = 0.78 inches DURATION = 6.5 hours

Sample No.	Gallons of Runoff	Total Coliform MPN/100ml	Fecal Coliform MPN/100ml	Fecal Strep. FS/100ml	Cl mg/l	TC mg/l	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	TKN mg/l	DKN mg/l	TP mg/l	TSS mg/l	pH	Temp. °C	Cond. µmho
1	1,000	110,000	110,000	80,000	31.0	37	1.60	.120	.51	2.6	2.2	.386	35	7.8	22	125
2	5,000	≥240,000	110,000	130,000	8.1	18	1.00	.046	.34	1.6	1.2	.322	77	7.9	22	90
3	10,000	46,000	46,000	77,000	6.0	15	.82	.031	.28	1.4	1.0	.386	64	7.4	22	55
4	15,000	≥240,000	24,000	92,000	11.0	15	.66	.027	.24	.8	.6	.252	36	7.6	22	80
5	20,000	≥240,000	110,000	69,000	5.7	13	.53	.024	.22	.7	.6	.217	50	7.4	22	55
6*	20,000	≥240,000	≥240,000	77,000	5.6	14	.51	.024	.22	1.0	.9	.219	61	7.4	22	55
7	40,000	≥240,000	46,000	106,000	3.0	8	.37	.016	.17	1.2	.5	.367	24	7.0	21	35
8	60,000	110,000	46,000	95,000	2.9	8	.24	.013	.10	.4	.2	.138	NS	7.2	19	30
9	65,000	46,000	46,000	86,000	2.6	8	.23	.015	.09	.4	.4	.130	26	7.4	19	35
EVENT MEAN CONCENTRATION																
		171,000	53,000	96,000	4.5	10.5	.47	.020	.19	1.02	.57	.300	35			
RAINWATER CHEMICAL ANALYSES																
					2.1	3	.09	.003	.07	NS	NS	NS	NS	5.6	18	13

METAL COMPOSITE:	RUNOFF (mg/l)	RAINWATER (mg/l)
Cu	<.02	<.02
Fe	.50	<.05
Mn	<.02	<.02
Cr	<.02	<.02
Ni	<.10	<.10
Zn	.10	<.10
Pb	<.20	<.20
Cd	<.02	<.02

*Replicate
NS=No Sample

Table 4-29
Stormwater Runoff Sampling (11-15/16-83)

TOTAL RAINFALL = 1.91 inches DURATION = 14.5 hours

Sample No.	Gallons of Runoff	Total Coliform MPN/100ml	Fecal Coliform MPN/100ml	Fecal Strep. FS/100ml	Cl mg/l	TC mg/l	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	TKN mg/l	TP mg/l	TSS mg/l	pH	Temp. °C	Cond. µmho
1	2,000	≥240,000	4,300	54,000	23.0	82	.18	.049	.32	1.2	.555	84	6.0	10	130
2	7,000	46,000	9,300	51,000	15.0	55	.11	.031	.24	.8	.505	52	6.0	9	88
3	15,000	46,000	4,300	44,000	11.0	41	.08	.022	.20	.4	.390	45	5.9	10	65
4	25,000	46,000	4,300	32,000	10.0	38	.06	.020	.17	.4	.345	20	6.2	10	60
5	35,000	110,000	2,400	28,000	9.7	39	<.05	.019	.17	.4	.390	50	6.5	9	63
6*	35,000	240,000	2,400	29,000	9.7	38	<.05	.019	.15	.4	.335	43	6.5	9	NS
7	50,000	46,000	4,300	20,000	6.2	26	<.05	.015	.13	.4	.300	25	6.4	9	43
8	85,000	110,000	930	27,000	3.6	17	<.05	.011	.11	.1	.166	20	6.2	9	NS
9	126,000	≥240,000	2,400	21,000	1.7	8	<.05	.012	.13	.5	.312	146	6.0	11	NS
10	175,000	110,000	2,400	6,200	2.8	13	<.05	.009	.10	<.2	.206	9	6.1	11	NS
11	225,000	15,000	930	7,400	2.1	11	<.05	.007	.08	<.1	.154	10	6.2	11	NS
12	275,000	46,000	4,300	8,600	2.5	16	<.05	.015	.11	.1	.205	11	6.4	12	NS
EVENT MEAN CONCENTRATION															
		71,000	2,000	14,000	3.83	16.8	.053	.012	.125	.295	.249	51			
RAINWATER CHEMICAL ANALYSES															
					1.1	2	<.05	.005	.07				3.3		

METAL COMPOSITE:	RUNOFF (mg/l)	RAINWATER (mg/l)
Cu	<.02	<.02
Fe	.30	<.05
Cr	<.02	<.02
Ni	<.10	<.10
Zn	<.10	<.10
Pb	<.20	<.20
Cd	<.02	<.02

*Replicate
NS=No Sample

Table 4-31 presents a comparison of the average of the EMC's for the chemical analyses of the three events performed at Lake Ronkonkoma to those of 23 rainfall events to those performed at the NURP site in Deer Park, New York. For the same reasons noted in the discussion of the bacterial samples, the NURP study concentrations rather than those derived from the three Lake Ronkonkoma sampling events were used for the load calculations for the Lake Ronkonkoma watershed.

Table 4-30
Comparison of Bacterial Data Between
Lake Ronkonkoma Sampling and NURP Sampling

BACTERIAL PARAMETER	LAKE RONKONKOMA	NURP	NURP (Warm Weather) (June through November)
Total Coliform	110,000	22,000	109,000
Fecal Coliform	10,000	5,000	17,000
Fecal Streptococcus	53,000	25,000	47,000
FC/FS	0.189	0.200	0.361
FC/TC	0.091	0.227	0.156

NOTE: 1. All Bacterial Concentrations MPN/100 ml.

2. Concentrations shown are geometric average of event mean concentrations from the following events.

Lake Ronkonkoma Data
Total Coliform and Fecal Coliform - 2 events
Fecal Streptococcus - 3 events

NURP Data: Deer Park, NY, Site
Total - 27 events
Warm Weather - 15 events sampled in months of June through November

Table 4-31
Comparison of Chemical Data Between
Lake Ronkonkoma Sampling and NURP Sampling

CHEMICAL PARAMETER	LAKE RONKONKOMA (mg/l)	NURP (mg/l)
TKN	1.36	1.25
NH_3-N	0.16	0.31
NO_3-N	0.30	0.54
NO_2-N	0.013	0.028
TP	0.37	0.22
DP	0.16*	NO DATA

NOTE: Lake Ronkonkoma Data are averages from event mean concentrations of 3 storm runoff events.

* DP is EMC from one storm runoff event.

NURP Data are averages from event mean concentrations of 23 storm runoff events.

4.4 GROUNDWATER QUALITY SURVEY

4.4.1 Introduction. Five groundwater monitoring wells were installed by the SCDHS within the groundwater contributory area north of Lake Ronkonkoma (Fig. 4-13). These wells were installed for the purpose of analyzing water quality conditions in the upgradient area that supplies groundwater to the lake. In addition to these five wells, one existing well (S47718), located at Old Portion Road, was included as part of the SCDHS sampling program.

4.4.2 Location of Sites. The locations of the monitoring wells were selected to represent land use patterns in the groundwater contributory area as accurately as possible.

Table 4-32 lists the wells and their identification number, location, length of well, depth to water, depth below the water table, screen length, and diameter of casing.

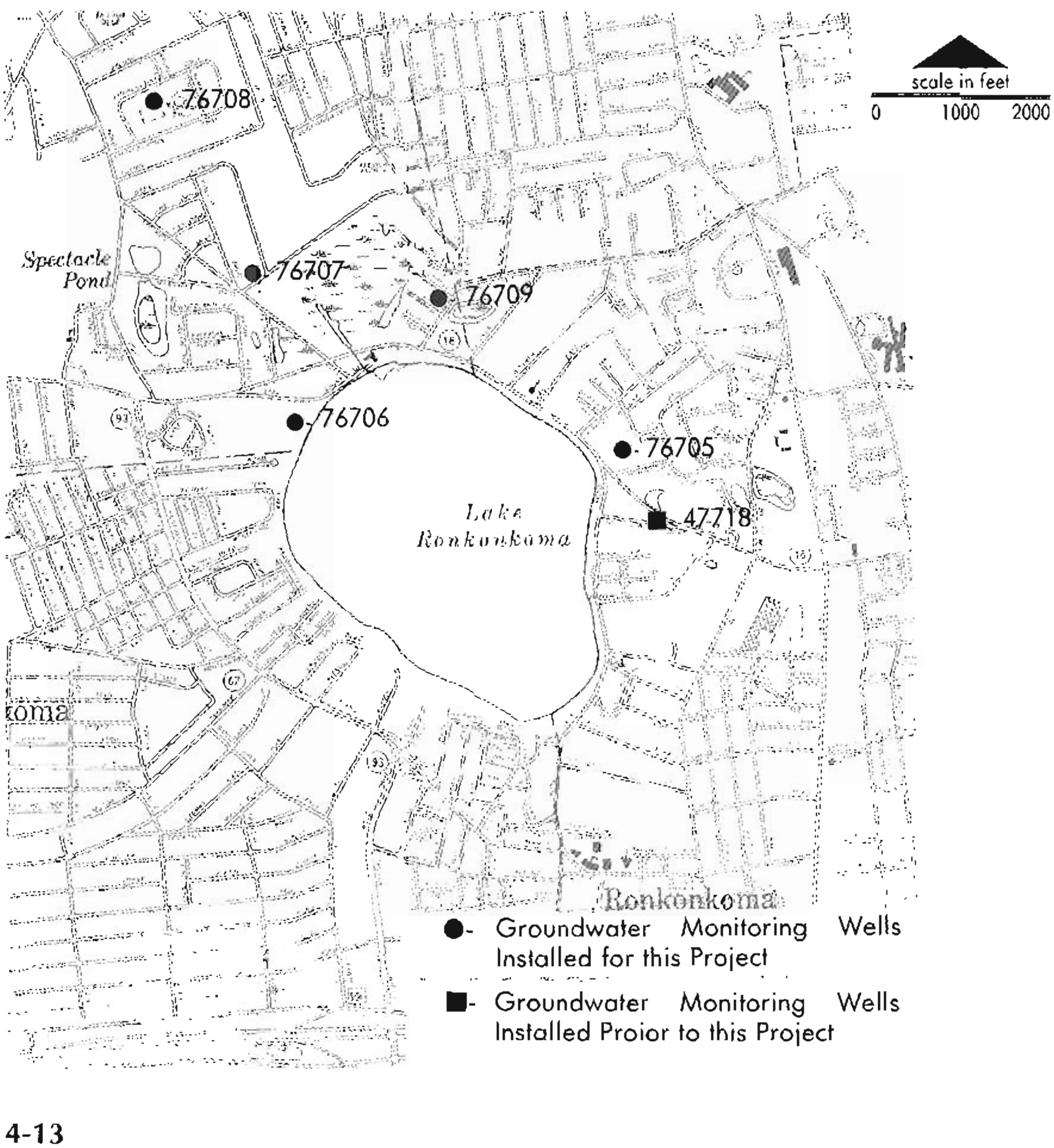


Figure 4-13
SCDHS MONITORING WELL SITES

Table 4-32
Groundwater Monitoring Wells Installed at Lake Ronkonkoma

IDENTIFICATION NUMBER	LOCATION	LENGTH OF WELL	DEPTH TO WATER	DEPTH BELOW WATER TABLE	SCREEN LENGTH	DIAMETER OF WELL
S 76706	Lake Shore Road	12′	0.66′	11.34′	5′	2″
S 76707	Great Marsh Rd.	15′	3.17′	11.83′	5′	2″
S 76708	Empress Pines Dr.	45′	13.87′	31.13′	5′	2″
S 76705	Shore Haven Blvd.	17′	11.75′	5.25′	2′	2″
S 76709	School House Rd.	25′	3.00′	22.00′	5′	2″
S 47718	Old Portion Rd.	49′	12.00′	37.00′	10′	4″

4.4.3 Background Information. After the wells were installed, several conditions became apparent that required the alteration of the original plans. Well S76706, on the north side of the lake, was the well installed nearest to the lake. It was sampled on April 18, 1984 for inorganic chemical analyses and on May 4, 1984 for organic chemical analyses. However, when the well was scheduled to be sampled on June 7, 1984, along with the other five wells, the water level of Lake Ronkonkoma had risen sufficiently to cover the top of the well casing, rendering it unusable for further sampling. The lake level continued to rise, leaving at least 18 inches of water covering the top of the casing as of January 1985 when the rest of the sampling program was completed.

Furthermore, two wells were installed in locations that failed to yield adequate quantities of water for sampling. Well S76705 at Shore Haven Boulevard was initially installed one street to the north on Newton Boulevard. It was moved to the present site after attempts to develop the site failed to provide a well that would yield a quantity of water sufficient for sampling.

Well S76709 was installed at School House Road in an area that contains soil categorized as Undifferentiated Muck. This soil contains partially decayed organic matter and supports swamp vegetation. It is usually very near the water table and is wet or saturated most of the time. Overlying this mucky soil is cut and fill soil which was placed in the area to permit development.

The first attempts to pump well S76709 were unsuccessful, since only a small volume of water was obtained. Additional efforts were undertaken to develop the well until an adequate quantity of groundwater could be obtained for sampling. The well yielded a sufficient rate of flow for the first thirty seconds it was pumped, then, after this initial surge, groundwater would spurt out at sporadic intervals. The sample collected from this well was always turbid and contained many fines.

Conditions in these wells illustrate two problems affecting Lake Ronkonkoma and its surroundings. First, they reflect the unexpected and dramatic rise in the lake water level during this time period. Second, they provide specific examples of the problems related to the different types of soils found around Lake Ronkonkoma. Since the soil is not homogeneous, it adds complexity in the estimation of the volume of groundwater underflow to the lake.

4.4.4 Methodology

4.4.4.1 Sampling Schedule. The groundwater monitoring wells at Lake Ronkonkoma were sampled once each month from June to November 1984. In addition, a sample from each well was collected at the time of installation in April or May of 1984.

4.4.4.2 Equipment and Collection Procedures. The groundwater was withdrawn from the monitoring wells using a centrifugal pump with a three horsepower engine and a 30-foot section of suction hose. It was standard procedure to pump each well for 15 minutes before each sample was collected. This was done to evacuate the well casing to assure that formation water was sampled, and to allow sufficient flushing of the pump and suction hose to prevent cross contamination of water from the previous well pumped.

The inorganic chemicals for which analyses were performed included chloride, nitrate-nitrogen, nitrite-nitrogen, ammonia-nitrogen, total Kjeldahl nitrogen, orthophosphate and total organic carbon. These samples were placed in 125 ml bottles that had been color-coded to indicate the desired analyses.

Samples to be analyzed for organic chemicals were collected in special glass bottles supplied by Suffolk County Department of Health Services Laboratory. Table 4-33 lists the 32 organic chemicals included in this sampling program and the analytical methodology.

Table 4-33
Organic Chemicals Included in Analysis of Groundwater Samples from Lake Ronkonkoma Monitoring Wells

Chloroform	o-Xylene
1,1,1 Trichloroethane*	m-Xylene
Carbon tetrachloride	p-Xylene
1,1,2 Trichloroethylene	Bromobenzene
Chlorodibromomethane	o-Chlorotoluene
Bromoform	m-Chlorotoluene
Tetrachloroethylene	p-Chlorotoluene
cis-Dichloroethylene	1,3,5 Trimethylbenzene
Freon 113	1,2,4 Trimethlybenzene
Bromodichloromethane	o-Dichlorobenzene
1,1,2 Trichloroethane	m-Dichlorobenzene
Benzene	p-Dichlorobenzene
Toluene	1,2,4,5 Tetramethylbenzene
Chlorobenzene	1,2,4 Trichlorobenzene
Ethylbenzene	1,2,3 Trichlorobenzene
p-Diethylbenzene	1,1,2,2 Tetrachloroethane

* The only organic chemical detected of the 32 analyzed.

Analytical method:
Analytical Handbook
Toxicology Center
Division of Laboratories and Research
New York State Department of Health
(1) Volatile Hydrocarbons in Water/Wastewater 310-10
(2) Volatile Halo-organics in Water 310-11

Field measurements for temperature and conductivity were done using a sample collected in one liter plastic containers and analyzed within two minutes following the time of collection. All groundwater samples were placed in coolers and transported to SCDHS Laboratories in Hauppauge for analysis. The analytical methods used for the parameters are described in Table 4-25.

4.4.5 Results. Tables 4-34 through 4-39 list the analytical results of the samples obtained from the groundwater monitoring wells near Lake Ronkonkoma.

Three of the wells were installed adjacent to residential properties. These wells are S76705 at Shore Haven Boulevard (Table 4-34), S76708 at Empress Pines Drive (Table 4-35), and S76709 at School House Road (Table 4-36). High concentrations of nitrate-nitrogen were detected at wells S76705 (average concentration of 10.8 mg/l) and S76708 (average concentration 9.4 mg/l). This suggests the groundwater may be influenced by leachate from the residential on-lot sewage disposal systems in the area. Detection of 1,1,1 trichloroethane in the six samples analyzed from well S76708 at Empress Pines Drive provided further evidence implicating sewage system leachate as the source of contamination. Trichloroethane has been the most frequently detected organic chemical found in private water supply wells in Suffolk County. Prior to 1980 it was a major ingredient in cesspool cleaning additives. It is also an ingredient in some household products such as cleaning fluids, paint thinners and removers, and degreasing agents. The presence of this organic compound together with the high nitrate-nitrogen levels demonstrates the possible impact of the residential land use on the groundwater upgradient (north) of Lake Ronkonkoma.

Table 4-34
Groundwater Quality Survey
Monitoring Well No. S76705 at Shore Haven Blvd.

Date Sampled	Chloride mg/l	TC mg/l	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	TKN mg/l	OPO_4-P mg/l	Conductivity µmho	Temp. °C	Organic Chemicals µg/l
5/18/84	NS	NS	NS	NS	NS	NS	NS	NS	NS	ND
6/7/84	22	12	12	.041	<.05	.30	<.002	NS	14	ND
7/12/84	21	NS	11	.001	.05	NS	.004	210	13	ND
8/16/84	21	NS	10	.002	<.05	NS	.002	295	13	ND
9/26/84	19	NS	10	.002	.06	.10	.005	NS	NS	ND
10/31/84	19	NS	10	.001	<.05	NS	.004	230	12	ND
11/28/84	22	18	12	.004	.09	NS	.009	290	18	ND
Average Concentration	21	15	11	.009	.06	.2	.005	256	--	--

Note: NS = No Sample
ND = None Detected

Table 4-35
Groundwater Quality Survey
Monitoring Well No. S76708 at Empress Pines Dr.

Date Sampled	Chloride mg/l	TC mg/l	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	TKN mg/l	OPO_4-P mg/l	Conductivity µmhos	Temp. °C	Organic Chemicals µg/l
5/4/84	24	NS	10	.007	.05	.20	NS	230	14	NS
6/7/84	25	11	9.6	NS	.05	.20	.006	NS	18	17µg/l1,1,1-Trichloroethane
7/12/84	24	NS	9.7	.012	.08	NS	.013	189	17	22µg/l 1,1,1-Trichloroethane
8/16/84	24	NS	9.1	.002	<.05	NS	.013	210	16	20µg/l 1,1,1-Trichloroethane
9/26/84	24	NS	9.5	.008	.09	.10	.018	NS	NS	13µg/l 1,1,1-Trichloroethane
10/31/84	24	NS	9.2	.027	.06	NS	.019	210	15	9µg/l 1,1,1-Trichloroethane
11/28/84	26	15	9.0	.011	.10	NS	<.002	200	16	10µg/l 1,1,1-Trichloroethane
Average Concentration	24	13	9.4	.011	.073	.17	.012	208	--	15µg/l 1,1,1-Trichloroethane

Note: NS = No Sample

Table 4-36
Groundwater Quality Survey
Monitoring Well No. S76709 at School House Rd.

Date Sampled	Chloride mg/l	TC mg/l	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	TKN mg/l	OPO_4-P mg/l	Conductivity µmhos	Temp. °C	Organic Chemicals µg/l
5/4/84	30	NS	<.05	.009	4.3	5.4	NS	190	20	ND
6/7/84	32	29	<.05	.013	4.6	5.2	.059	NS	22	ND
7/12/84	30	NS	<.05	.027	4.6	NS	.121	185	20	ND
8/16/84	27	NS	<.05	.013	4.5	NS	.081	200	20	ND
9/26/84	26	NS	<.05	.012	3.8	4.0	.141	NS	NS	ND
10/31/84	25	NS	.07	.018	4.8	NS	.013	168	19	ND
11/28/84	24	34	.09	.032	5.0	NS	.064	178	18	ND
Average Concentration	28	32	.06	.018	4.5	4.9	.080	184	--	--

Note: NS = No Sample
ND = None Detected

Table 4-37
Groundwater Quality Survey
Monitoring Well No. S47718 at Old Portion Rd.

Date Sampled	Chloride mg/l	TC mg/l	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	TKN mg/l	OPO_4-P mg/l	Conductivity µmhos	Temp. °C	Organic Chemicals µg/l
6/7/84	26	11	<.05	.004	.36	.70	.004	NS	17	ND
7/12/84	23	NS	<.05	<.001	.29	NS	.006	176	17	ND
8/16/84	18	NS	.26	.002	.24	NS	.005	210	14	ND
9/26/84	16	NS	<.05	.002	.26	.30	.005	NS	NS	ND
10/31/84	14	NS	.13	.001	.22	NS	NS	175	12	ND
11/28/84	14	17	.15	.004	.26	NS	.007	168	12	ND
Average Concentration	19	14	.12	.002	.27	.50	.005	182	--	--

Note: NS=No Sample
ND=None Detected

Table 4-38
Groundwater Quality Survey
Monitoring Well No. S76706 at Lake Shore Rd.

Date Sampled	Chloride mg/l	TC mg/l	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	TKN mg/l	OPO_4-P mg/l	Conductivity µmhos	Temp. °C	Organic Chemicals µg/l
4/18/84	7.1	<.05	.003	.16	1.1	NS	NS	NS	NS	NS
5/4/84	NS	NS	NS	NS	NS	NS	NS	NS	NS	ND

Note: NS=No Sample
ND=None Detected

The lake level rose to a height above the top of this well casing between 5/4/84 and 6/7/84 and never receded below the top of the well casing during the remainder of this study.

Table 4-39
Groundwater Quality Survey
Monitoring Well No. S76707 at Marsh Rd.

Date Sampled	Chloride mg/l	TC mg/l	NO_3-N mg/l	NO_2-N mg/l	NH_3-N mg/l	TKN mg/l	OPO_4-P mg/l	Conductivity µmhos	Temp. °C	Organic Chemicals µg/l
4/18/84	5.5	NS	<.05	.005	<.05	.60	NS	NS	NS	NS
7/12/84	6.9	NS	.07	.003	14	NS	.012	51	14	ND
8/16/84	6.8	NS	.22	.002	.11	NS	.005	85	14	ND
9/26/84	6.3	NS	.12	.003	14	.50	.010	NS	NS	NS
10/31/84	6.4	NS	.12	.003	11	NS	.003	68	15	ND
11/28/84	6.6	8	.11	.003	.15	NS	.003	82	14	ND
Average Concentration	6.4	--	.12	.003	12	.55	.007	72	--	--

Note: NS=No Sample
ND=None Detected

Sampling results from the third well adjacent to residential property, S76709 at School House Road, reflected a somewhat different set of groundwater conditions. Rather than the high nitrate-nitrogen concentrations noted in the samples from the other two wells adjacent to residential property, the levels in this well were low (average concentration 0.06 mg/l). However, the ammonia-nitrogen levels were much higher, with an average concentration of 4.87 mg/l compared to an average of 0.07 mg/l at well S76708 and 0.06 mg/l at well S76705.

The depth to water at School House Road was only three feet, which means that, at present, the on-lot systems are either slightly above or partially submerged in the water table. Thus, sewage leaching from the systems in this area would rapidly enter the groundwater and be subjected to anaerobic conditions. In the absence of an aerated or unsaturated zone through which leachate could percolate, there would be no opportunity for the soil bacteria to oxidize the ammonia to nitrate, thereby producing higher concentrations of nitrate-nitrogen in the groundwater as evident at the other two wells.

The higher concentration of orthophosphate found at the School House Road well, (average concentration 0.08 mg/l) compared to Shore Haven Boulevard (average concentration 0.005 mg/l) and Empress Pines Drive (average concentration 0.012 mg/l), lends further support to this explanation, since phosphate leaching through an unsaturated zone is more likely to be adsorbed by the soil and not enter the groundwater. *The Long Island Groundwater Pollution Study* reported a 92.0 to 99.9 percent reduction of total phosphate from cesspool leachate that traveled through 12 feet of unsaturated sands.[1]

Finally, other properties of the soil may partially explain the unusually high concentrations of ammonia-nitrogen and orthophosphate at School House Road. As stated previously, well S76709 at School House Road was installed in soil classified as Muck which had been covered with cut and fill soil. The difficulty experienced in pumping this well would indicate that the soil was not highly permeable. Thus, any leachate from nearby cesspools would tend to remain within the same area for long periods of time and would not be subject to the diluting effects from groundwater flow as in an area of higher hydraulic conductivity.

Well S47718 at Old Portion Road was located on a triangular section of vacant land at the intersection of Portion and Old Portion Roads. Table 4-37 shows that the chloride concentrations and conductivity were within the range of the three wells adjacent to residential properties, but, concentrations of other inorganic chemicals were noticeably lower. This well was probably at a sufficient distance from on-lot sewage systems so that the effects of leachate from sewage systems were diminished. However, this well still had high enough chloride concentrations and conductivity readings to indicate some impact from land use activities.

The remaining two wells that were monitored, S76706 and S76707, (Tables 4-38 and 4-39), were both installed on the north side of Lake Ronkonkoma where there is shallow depth to water and the areas are relatively free of nearby influences of residential or commercial land use. As previously stated, well S76706 was installed only a few feet north of the lake in April 1984. It was sampled once at the time of installation for inorganic chemicals and once for organic chemical analysis. No organic chemicals were detected, and very low concentrations of inorganic chemicals were present. Unfortunately, the rising lake level precluded further monitoring.

Well S76707 was installed along a dirt road in the midst of a section of undeveloped parkland on the north side of the bog. The length of this well was 15 feet, and the depth to water was 3.17 feet. The well had a five-foot screen which extended from 6.83 to 11.83 feet below the water table. Therefore any impacts on the groundwater collected from this well would be derived from the wooded area in the immediate vicinity. As expected, samples collected from this well displayed the best water quality of the five wells that were extensively monitored.

As in the case of other SCDHS monitoring programs, it is evident that the data from the shallow monitoring wells tend to reflect the land use in the area in which they are located. The proximity of the wells to on-lot cesspools, the extent of the zone of aeration or the depth to water, and the type of the soil conditions all seemed to influence the type and concentration of chemicals found in the water.

Estimates of the quality of groundwater inflow to the lake were derived from the data and used in the calculation of overall pollutant loads. These estimates are presented in Chapter 6.

[1] New York State Department of Environmental Conservation, 1972, The Long Island Groundwater Pollution Study, New York State Department of Environmental Conservation, SAN-P3 (11/72), pp. 8-20.

Chapter 5....

Analysis of the Water Budget for Lake Ronkonkoma

5.0 ANALYSIS OF THE WATER BUDGET FOR LAKE RONKONKOMA

A water budget analysis for any area is an accounting of the quantities of all the items that comprise inflow, outflow and change in storage for the system. The components of the water budget are related by the equation: **Inflow = Outflow + Change** in Storage. Elements of the water budget, either individually or in combination, change in response to natural hydrologic events or human induced impacts. Under natural conditions, the hydrologic system of Long Island is considered to be in long term dynamic equilibrium, whereby inflow is equal to outflow and the average net change in storage is zero. For the purposes of this study, estimates have been made of average inflow, outflow and storage for the lake.

5.1 INFLOW.

There are four components of total water inflow to Lake Ronkonkoma. They are groundwater underflow, surface water inflow (stream base flow, stream wet weather flow and recharge basin pumpage), direct precipitation and stormwater runoff. The development of estimates of these sources of water was an integral part of this study. These estimates were combined with the water quality data presented in Chapter 4, to calculate the quantity of chemical and bacterial pollutants that each component of inflow contributes to the lake (Chapter 6).

5.1.1 Groundwater Underflow.

In the absence of direct seepage measurements, the estimate of groundwater underflow to Lake Ronkonkoma was based on findings derived from a model developed by McBride and Pfannkuch (1975). This model was used to calculate the exchange of water between a lake and the contiguous permeable groundwater flow system. The modelers predicted that significant rates of seepage would occur within a narrow strip from the shore of the lake. Later, the authors empirically verified the model with measurements of seepage in Lake Sallie, Minnesota. This verification demonstrated that near shore seepage occurred independent of the presence of fine-grained, low permeable sedimentary materials in the central part of the lake. Their model indicated that the velocity of seepage decreases at an exponential rate as a function of distance from the shore. The predicted rate of decrease was one order of magnitude for every 60 meters of distance. For this study, it is assumed that the conditions at Lake Sallie are comparable to those of Lake Ronkonkoma.

At Lake Ronkonkoma, groundwater flow is generally from north to south. Assuming the rate of seepage decreased one order of magnitude per 60 meters from the shoreline, the zone of seepage was extended 120 meters from the shoreline into the lake. The area within the zone was determined to be 22.1 acres and the mean seepage percentage was then computed as 22% for the entire 22.1 acre area.

Darcy's law for groundwater flow (**Q = A•K•dh/ds**) was employed to compute a mean groundwater underflow to the lake. The area (**A**) (22.1 acres), was multiplied by the mean seepage (22%) to yield 4.862 acres (19,676 m^2). Hydraulic conductivity (**K**) was estimated for the upper glacial aquifer in the vicinity of Lake Ronkonkoma to be 500 gpd/ft^2 or 7436 m^3 py/m^2. An estimated average hydraulic gradient (dh/ds) employed was 0.0013 (range 0.0005 - 0.0020). The results of this calculation was 191,227 m^3 per year which was rounded off to 200,000 m^3 per year of groundwater underflow to the lake.

5.1.2 Surface Water Inflow

5.1.2.1 Stream Base Flow.

Long term USGS stream gaging data at this *partial record station* indicate that 0.55 cfs is the average base flow of the stream flowing from the Great Bog under Smithtown Boulevard to Lake Ronkonkoma. A flow of 0.55 cfs is equivalent to 491,152 m^3 per year which was rounded off to 500,000 m^3 per year.

5.1.2.2 Stream Wet Weather Flow.

Due to the flooding condition that occurred during the study it was impossible to measure wet weather stream flow. This component of the water budget has been accounted for in the estimates of precipitation and stormwater runoff that follow.

5.1.2.3 Pumpage from Recharge Basins.

The only available estimate of yearly pumpage volume, from the three recharge basins north of Lake Ronkonkoma to the Great Bog, was obtained from a previous study (Chapter 4). This estimate of 223,280 m^3 per year is based upon the yearly electric consumption at the pumping station. It has been rounded off to 225,000 m^3 per year for this study.

5.1.3 Direct Precipitation. Mean precipitation in the Lake Ronkonkoma area is estimated at 50 inches per year. Evaporation was estimated at 34 inches per year (USGS) leaving a net precipitation of 16 inches per year to the lake. This volume of rainfall fell upon 237 acres of lake area and 43 acres of water surface in the Great Bog to provide a yearly precipitation of 460,499 m^3 which was rounded off to 460,000 m^3. Precipitation onto the Great Bog is included as partial allocation of the increased stream flow during wet weather.

5.1.4 Stormwater Runoff. The stormwater runoff contributory area was estimated to be 300 acres (Chapter 4). Based upon a yearly mean rainfall of 50 inches and a runoff coefficient of 0.20, a yearly runoff volume of 308,370 m^3 enters the lake. A volume of 300,000 m^3 per year was applied in this study. As with direct precipitation, a portion of the total runoff accounts for part of the increased stream flow during wet weather.

5.2 OUTFLOW. There are two natural processes by which water is removed from Lake Ronkonkoma. They are evaporation and groundwater underflow (outflow). There is no surface water outlet from Lake Ronkonkoma. Evaporation accounts for 34 inches (980,000 m^3/yr) of the 50 inches (1,440,000 m^3/yr) of direct precipitation that fall upon Lake Ronkonkoma and the Great Bog annually. During normal or steady-state conditions, inflow to the lake is equivalent to outflow; therefore, groundwater underflow leaving the lake equals the sum of groundwater underflow (inflow), surface water inflow (stream base flow, stream wet weather flow and pumpage), net direct precipitation (460,000 m^3/yr) and stormwater runoff. This amount has been estimated to be 1,685,000 m^3 per year which is equivalent to 0.42 lake volume.

5.3 STORAGE. In this study the storage component of the water budget has been considered to be equivalent to the average lake volume, which was calculated as 4,000,000 m^3 (Chapter 2).

5.4 SUMMARY. Table 5-1 is a summary presentation of selected items used to calculate some of the components of the water budget. The elements of the water budget are shown in Table 5-2. As indicated, based on an annual net inflow rate of 1,685,000 m^3 and estimated lake volume of 4,000,000, the lake has a retention time of 2.5 years and flushing rate of 0.42 volumes per year.

Table 5-1
Values Used to Calculate
Selected Components of Water Budget

GROUNDWATER UNDERFLOW	
(K)Conductivity (Overall mean for the Upper Glacial Aquifer at Lake Ronkonkoma)	500 gpd/ft^2 (7436m^3/yr/m^2)
(A)Seepage Area	22.1 Acres (89,434m^2)
Mean Seepage Percentage	22%
(dh)/(ds)(Hydraulic Gradient)	0.0013 m/m (range 0.0005-0.0020)
DIRECT PRECIPITATION (Net)	
Mean Precipitation	50 inches per year (1.27m/yr)
Mean Evaporation	34 inches per year (0.86m/yr)
Lake Surface Area	237 acres (959,139m^2)
Great Bog Surface Area	43 acres (174,171 m^2)
STORMWATER RUNOFF	
Runoff Contributory Area	300 acres (1.214 x $10^6 m^2$)
Runoff Coefficient	0.20

Table 5-2

Annual Water Budget For Lake Ronkonkoma

COMPONENT of WATER BUDGET	YEARLY VOLUME	% of INFLOW
A. Inflow		
1. Groundwater Underflow	200,000 m^3	12%
2. Surface Water Inflow		
a. Stream Base Flow	500,000 m^3	30%
b. Pumpage	225,000 m^3	13%
3. Direct Precipitation (Net) (1,2)	460,000 m^3	27%
4. Stormwater Runoff (2)	300,000 m^3	18%
Net Inflow	1,685,000 m^3	100%
B. Outflow		
Net Inflow = Net Outflow (3)	1,685,000 m^3	
C. Storage		
Lake Volume	4,000,000 m^3	
Lake Retention Time	2.5 years	
Flushing Rate	0.42 Lake volume per year	

(1) Net Precipitation = Total precipitation (1,440,000 m^3/yr) - (less) Evaporation (980,000 m^2/yr)

(2) A portion of these components is increased wet weather stream flow.

(3) Groundwater Underflow (Outflow)

Chapter 6....

Analysis of Water Quality Inputs to Lake Ronkonkoma

6.1 INTRODUCTION

Under normal hydrogeological conditions, there are four water quality inputs to the lake: groundwater underflow, surface water inflow (stream base flow, stream wet weather flow, and pumpage from recharge basins), direct precipitation and stormwater runoff. During this study, especially throughout most of 1984, these inputs were significantly altered. The above average rainfall and accompanying high lake water levels prevented streamflow from the bog to the lake and caused localized flooding. A planned program to sample the stream flow during both dry weather and wet weather had to be cancelled. Runoff sampling was abbreviated because the high lake levels inundated the sampling site. It is also possible that the high lake water levels may have suppressed the amount of groundwater underflow into the lake. In addition, the lack of a flow meter at the pump station severely hindered the assessment of the input from the recharge basins north of the lake. Despite these serious problems, an attempt has been made to derive reasonable estimates for all water quality inputs to the lake under normal conditions.

6.1.1 Groundwater Underflow. Groundwater underflow to Lake Ronkonkoma has been estimated for this study to contribute approximately 200,000 cubic meters of water per year to the lake. This accounts for about 12% of the total volume of water supplied to the lake each year (Table 5-2).

The chemical quality of the groundwater underflow to Lake Ronkonkoma was analyzed by sampling five groundwater monitoring wells installed upgradient of the lake. Table 6-1 shows the average values for five chemical parameters analyzed (NO_3-N, NO_2-N, NH_3-N, TKN and $O-PO_4$). Table 6-1 also shows the average concentration values for the chemical parameters as previously listed, with the exception of TKN, as indicated in the groundwater quality data recently compiled for the *Suffolk County Comprehensive Water Resources Plan*. These data were compiled from monitoring wells installed in areas of vacant land and medium density residential land in Suffolk County; the same land uses in which the Lake Ronkonkoma monitoring wells were installed.

Comparisons were made to determine if the groundwater quality data from the five monitoring wells near Lake Ronkonkoma were similar to the groundwater samples from other areas of Suffolk County with comparable land uses. As a result, estimates were made of average concentration values of chemical parameters to be applied in calculating contaminant lands contributed by the groundwater underflow supplying Lake Ronkonkoma (Table 6-1).

Groundwater quality associated with vacant land and medium density residential land use, was given equal weight in estimating the concentration of each chemical parameter. Immediately upgradient (north) of the lake, most of the land is vacant, and farther north, medium density residential development predominates. Although the area of vacant land is smaller than that of medium density residential land upgradient of the lake, the vacant land is closer to the lake. Therefore, the vacant land could be expected to exert a greater influence on the chemical quality of the groundwater underflow to the lake, in proportion to its area, than the medium density residential areas.

The concentrations of the groundwater chemical parameters were multiplied by the yearly volume of groundwater underflow to Lake Ronkonkoma to determine a yearly load to the lake (Table 6-2).

6.1.2 Surface Water Inflow. Surface water flows from the bog, on the north side of the lake, into Lake Ronkonkoma via a culvert underneath County Road 16. There are three basic components to this surface water flow; base stream flow, wet weather stream flow and pumpage from three recharge basins north of the bog.

Base flow of the stream leading from the bog to Lake Ronkonkoma has been gauged periodically for many years by the USGS and was estimated to be 491,280 cubic meters per year in the Holzmacher study.[1] This volume has been rounded off to 500,000 cubic meters per year for this report. All components of the water budget for Lake Ronkonkoma have been rounded off in this report to indicate that these values are estimates, and not precise quantities. It also allows for easier comparisons among the components of the water budget of Lake Ronkonkoma.

[1]op. cit., Holzmacher et al., 1980, 33.12 p.

Table 6-1
Chemical Quality of Groundwater Underflow to Lake Ronkonkoma

LAKE RONKONKOMA GROUNDWATER MONITORING WELLS

WELL NUMBER	LOCATION	CHEMICAL PARAMETERS (mg/l)				
		NO_3-N	NO_2-N	NH_3-N	TKN	O-PO_4
S 76705	Shore Haven Blvd.	11.0	.009	0.06	0.2	.005
S 76708	Empress Pines Drive	9.4	.011	0.073	0.17	.012
S 76709	School House Road	0.06	.018	4.5	4.9	.080
S 47718	Old Portion Road	0.12	.002	0.27	0.5	.005
S 76707	Marsh Road	0.12	.003	0.12	0.55	.007
	Average of Five Wells	4.14	.0086	1.01	1.26	.002

LAND USE MONITORING WELLS
Suffolk County Comprehensive Water Resources Plan

LAND USE	CHEMICAL PARAMETERS (mg/l)				
	NO_3-N	NO_2-N	NH_3-N	TKN	O-PO_4
Vacant Land	1.15	.002	.005	ND*	.002
Medium Density Residential	5.82	.002	.12	ND*	.005
Average of Land Use Wells	3.49	.002	.085	ND*	.0035

ESTIMATED CONCENTRATION VALUES USED TO CHARACTERIZE GROUNDWATER UNDERFLOW QUALITY TO LAKE RONKONKOMA

NO_3-N	NO_2-N	NH_3-N	TKN	O-PO_4
4.0 mg/l	.005 mg/l	1.0 mg/l	1.0 mg/l	.003 mg/l

ND* = No Data

Table 6-2
Annual Chemical Loads From Groundwater Underflow to Lake Ronkonkoma

CHEMICAL PARAMETER	CONCENTRATON (mg/l)	UNDERFLOW VOLUME (M^3/yr)	TOTAL ANNUAL LOAD to LAKE (g/yr)
TK-N	1.0	200,000	2×10^5
NH_3-N	1.0	200,000	2×10^5
NO_3-N	4.0	200,000	8×10^5
NO_3-N	0.005	200,000	1×10^3
O-PO_4	0.003	200,000	6×10^2

Pumpage from the three recharge basins is considered here as a separate input to the Lake Ronkonkoma water budget. This pumpage is discharged into the northeast corner of the bog, travels through the bog where it combines with the base stream flow and enters Lake Ronkonkoma by way of the culvert. The estimate of this pumpage, 225,000 cubic meters per year (Holzmacher, 1980), is in addition to the 500,000 cubic meters of yearly base stream flow from the bog.

Because there is no flow meter, the yearly pumpage estimate was based on electric usage at the pump station during 1978 and 1979. The electric meter readings were compiled at a time when only two recharge basins were being pumped to the bog, instead of the three basins, which are presently being pumped.

Water quality samples were collected where the stream enters the lake. These samples were collected during both ambient (dry weather) conditions and during rainfall conditions. Dry weather samples were collected at sampling location LR-6 and analyzed for chemical constituents on 19 occasions and bacterial constituents on 7 occasions. Results of these analyses are listed in Appendix B, Part 2 Table 1. The averages for the chemical analyses and the geometric mean concentrations for the bacterial analyses are listed in Table 6-3.

Table 6-3
Water Quality of Stream Flow to Lake Ronkonkoma and Pumpage from Recharge Basins to Bog

PARAMETER	1. STREAM FLOW DURING AMBIENT CONDITIONS (LR-6)	2. STREAM FLOW DURING RAINFALL CONDITIONS (LR-11)	3. PUMPAGE FROM RECHARGE BASINS to BOG (LR-21)
TKN mg/l	0.830	0.900	1.400
NH_3-N mg/l	0.570	0.600	0.330
NO_3-N mg/l	0.630	0.530	1.290
NO_2-N mg/l	0.026	0.013	0.024
T.P. mg/l	0.031	0.053	0.044
Total Coliform (MPN/100ml)	1022	4571	8511
Fecal Coliform (MPN/100ml)	121	661	912

Wet weather samples were collected at the site identified as LR-11. These samples were analyzed for chemical constituents on 11 occasions and bacterial constituents on 13 occasions. The results of these analyses are listed in Table 4-13 through 4-22. The mean concentration of the chemical analyses and the geometric mean values for the bacterial analyses are also listed in Table 6-3.

In addition to the lake samples collected during dry weather and rainfall conditions, a series of samples were collected from the water pumped from the recharge basins at the point where the water is discharged into the bog. This sampling site was identified as LR-21 and samples were collected on eight occasions for analysis of both chemical and bacterial constituents. The results of these analyses are listed in Tables 4-13 through 4-22. The mean values for the chemical analyses and the geometric mean concentrations for the bacterial analyses are listed in Table 6-3.

Chemical and bacterial loads to Lake Ronkonkoma were calculated for the stream flow and the pumpage to the lake. Average concentration values for these two inputs of water were developed based on the individual grab samples collected during the course of the study. These concentration values were multiplied by the yearly volume of water provided by each input to arrive at a yearly mass load.

In the absence of the base stream flow sampling program that was precluded by the flooding of 1984, it became necessary to substitute concentration values derived from samples from the source that most closely resembles the base flow of the stream from the bog to the lake. These samples were collected at sampling station LR-6. Their average concentration values, listed in Table 6-3, were multiplied by the estimated 500,000 cubic meters of flow to obtain the yearly load to the lake for this component of the hydrologic budget (Table 6-4).

Table 6-4
Annual Water Quality Loads
from Stream Base Flow to Lake Ronkonkoma

CHEMICAL	AVERAGE AMBIENT CONCENTRATION (LR-6)	YEARLY STREAM FLOW VOLUME (M^3/yr)	YEARLY LOAD to LAKE RONKONKOMA
TKN	0.83 mg/l	500,000	4.15×10^5 g/yr
NH^3-N	0.57 mg/l	500,000	2.85×10^5 g/yr
NO^3-N	0.63 mg/l	500,000	3.15×10^5 g/yr
NO^2-N	0.026 mg/l	500,000	1.3×10^4 g/yr
T.P.	0.031 mg/l	500,000	1.55×10^4 g/yr
Total Coliform	1022 MPN/100ml	500,000	5.11×10^{12} (MPN/yr)
Fecal Coliform	121 MPN/100ml	500,000	6.05×10^{11} (MPN/yr)

The samples collected at the discharge of the recharge basins to the bog at site LR-21 represent the condition of this water entering the bog. Concentration values presented in Table 6-3 were then multiplied by the estimated pumpage volume of 225,000M^3 to arrive at an estimated pumpage load to the lake (Table 6-5). Water quality impact to the lake was calculated in this manner because the pumpage water over time has created a stream channel through the bog that connects to the main stream flow.

Table 6-5
Annual Water Quality Loads of Pumpage
from Recharge Basins to Lake Ronkonkoma

CHEMICAL PARAMETER	AVERAGE CONCENTRATION	PUMPAGE VOLUME PER YEAR (M^3/yr)	TOTAL ANNUAL LOAD to LAKE
TKN	1.4 mg/l	225,000	3.150×10^5 g/yr
NH_3-N	0.33 mg/l	225,000	7.425×10^4 g/yr
NO_3-N	1.29 mg/l	225,000	2.903×10^5 g/yr
NO_2-N	0.024 mg/l	225,000	5.403×10^3 g/yr
T.P	0.044 mg/l	225,000	9.903×10^3 g/yr
Total Coliform	8,511 MPN/100ml	225,000	1.916×10^{13} MPN/yr
Fecal Coliform	912 MPN/100ml	f25,000	2.053×10^{12} MPN/yr

An investigation of a natural impoundment, conducted as part of the Long Island Segment of the Nationwide Urban Runoff Program (NURP) found very little attenuation of stormwater waste loads because of the substantial amount of short circuiting typical of in most impoundments. Short circuiting of pumpage flow may be possible in the case of the bog. Wet weather lake water quality at site LR-11 reflects the input of several sources, including stream base flow, pumpage from the recharge basins and wet weather stream flow together with other lake influences. Estimates of the inputs from stream baseflow and from pumpage have been described previously. Wet weather streamflow includes baseflow plus the increased flow caused by rainfall on the bog and stormwater runoff into the bog. The latter two portions of wet weather streamflow are accounted for in the computations of direct precipitation and runoff. Calculating the wet weather streamflow water quality input using this method could be somewhat inaccurate because it is impossible to discern whether there is any flushing of additional bacteria and chemicals from the bog itself during rainfall conditions. This once again underscores the importance of the planned streamflow sampling program that had to be cancelled because of the flooding. Although the sampling results from site LR-11 are indicative of the wet weather water quality of the lake near the mouth of the stream, the results were not particularly useful in estimating any one of the inputs to the lake.

6.1.3 Direct Precipitation. Given a mean annual rainfall of 50 inches, a lake surface area of 237 acres and a bog surface area of 43 acres, approximately 1,440,000 cubic meters of direct precipitation can be expected to fall onto Lake Ronkonkoma each year. About 980,000 cubic meters of this volume are removed by evaporation, leaving a net annual input of 460,000 cubic meters to the water budget of the lake (Table 5-2). This represents about 27% of the total volume of water supplied to the lake each year.

Samples of wetfall were collected at Lake Ronkonkoma during the same three rainfall events that were sampled for direct runoff entering the lake (Tables 4-27, 4-28 and 4-29). The results of these wetfall analyses have been averaged and listed in Table 6-6. Since only three storm events were used to calculate the average concentrations of the chemical parameters, the data were compared with other wetfall data from more extensive studies completed on Long Island.

Table 6-6
Comparison of Wetfall Data From Various Locations on Long Island
(mg/l)

CHEMICAL PARAMETER	1 LAKE RONKON. STUDY 3 EVENTS	2 NURP STUDY CENTRAL AVENUE 22 EVENTS	3 NURP STUDY PERRY AVE. 9 EVENTS	4 NURP STUDY UNQUA PD. 5 EVENTS	5 NURP STUDY AVERAGE of 36 EVENTS	6 NURP STUDY AVERAGE of 3 SITES	7 SCDEC REPORT MINEOLA	8 SCDEC REPORT UPTON	9 SCDEC REPORT MEDFORD
TKN	.6	.695	.279	.729	.648	.572	---	---	---
NH_3-N	.11	.305	.095	.186	.241	.195	.48	17	.43
NO_3-N	.11	.383	.370	.297	.360	.350	.66	.34	.67
NO_2-N	.003	.017	.005	.005	.011	.009	---	---	---
T.P.	.015	.030	.051	.072	.043	.051	---	---	---

Wetfall analyses from storm events were performed at three different surface water sites during the Long Island Segment of the NURP study. The three sites were Central Avenue in Deer Park (22 events), Perry Avenue in Bayville (9 events) and Unqua Pond In Massapequa (5 events). The mean concentration for the chemical parameters analyzed at each site are also listed in Table 6-6.

As part of this evaluation, all 36 storm events analyzed during the NURP study were included in the computations of average chemical concentrations for all the storms. This method gives equal weight to each storm event analyzed. An alternate method was the calculation of an average using results obtained at the three NURP study sites. This gave equal weight to each site; whereas, the average of all 36 storms was biased in favor of the Deer Park site, which provided 22 of the 36 storm events analyzed.

An additional comparison of wetfall data was also provided from a study completed by the Suffolk County Department of Environmental Control in 1974.[1] This study included wetfall analysis from three different locations on Long Island. The locations were Mineola in Nassau County, and Upton and Medford in Suffolk County. Two of the chemical parameters of interest at Lake Ronkonkoma being compared, NO_3-N and NH_3-N, were analyzed in this study (Table 6-6).

Upon evaluation of the data it was decided that the most appropriate concentrations to use were the averages calculated from the three site averages used in the NURP study (Table 6-6, column 6). These concentrations were then multiplied by the yearly gross volume of precipitation (1,440,000 cubic meters) that enters the lake. Even though an estimated 980,000 cubic meters of precipitation evaporates from the lake each year, it is assumed that the chemical constituents in the total precipitation remains in the lake regardless of the evaporation process that reduces the net volume of the precipitation to 460,000 cubic meters per year. The yearly loads to the lake supplied by wetfall are calcualted in Table 6-7.

Table 6-7

Annual Chemical Loads from Precipitation Into Lake Ronkonkoma

CHEMICAL PARAMETER	AVERAGE CONCENTRATION (mg/l)	PRECIPITATION VOLUME (M^3/yr)	TOTAL LOAD TO LAKE (g/yr)
TKN	0.572	1,440,000	8.24×10^5
NH_3-N	0.195	1,440,000	2.80×10^5
NO_3-N	0.350	1,440,000	5.04×10^5
NO_2-N	0.009	1,440,000	1.30×10^4
T.P.	0.051	1,440,000	7.34×10^4

6.1.4 Stormwater Runoff. The boundaries of the area contributing runoff to Lake Ronkonkoma were delineated during this study (Fig. 4-11). Multiplication of the approximately 300 acres of land that constitute this area by the estimated runoff coefficient of .20 and the 50 inches of annual rainfall yields an estimate of 300,000 cubic meters of runoff into Lake Ronkonkoma. Runoff, therefore, accounts for approximately 18% of the 1,685,000 cubic meters of water which enter the lake each year (Table 5-2).

Water quality data for the runoff to Lake Ronkonkoma, both chemical and bacterial, are discussed in Chapter 4 of this report (Tables 4-27 and 4-29). As indicated, the *Event Mean Concentrations* (EMC's) that are applied to the runoff volume, were derived from data generated as part of the Long Island Segment of the Nationwide Urban Runoff Program (NURP). (See the Appendix for the concept and formula for EMC's.) The EMC's were then multiplied by the yearly volume of runoff that enters the lake to arrive at the yearly loads to Lake Ronkonkoma (Table 6-8).

[1]Suffolk County Department of Environmental Control, *Contaminants in Rainwater and Their Relation to Water Quality*, Frizzola, J.A. and Baier, J.H., 1974., 26 p.

Table 6-8
Annual Water Quality Loads From Stormwater Runoff to Lake Ronkonkoma

CHEMICAL PARAMETER	EMC	PRECIPITATION VOLUME (M^3/yr)	TOTAL LOAD to LAKE (g/yr)
TKN	1.36 mg/l	300,000	4.08×10^5 g/yr
NH_3-N	0.16 mg/l	300,000	4.8×10^4 g/yr
NO_3-N	0.30 mg/l	300,000	9.0×10^4 g/yr
NO_2-N	0.013 mg/l	300,000	3.9×10^3 g/yr
T.P.	0.37 mg/l	300,000	1.11×10^5 g/yr
Total Coliform	22,254 (MPN/100ml)	300,000	6.6762×10^{13} (MPN/yr)
Fecal Coliform	4,952 (MPN/100ml)	300,000	1.4856×10^{13} (MPN/yr)
Fecal Strep.	25,229 (MPN/100ml)	300,000	7.5687×10^{13} (MPN/yr)

6.2 SUMMARY

Table 6-9 summarizes the volume of water contributed by each component of the lake's water budget together with the chemical and bacterial loads entering the lake each year.

The data are presented in this format to aid in decision making while developing a management plan for the Lake Ronkonkoma area. Calculated volumes, concentrations and yearly loads should not be construed as absolute values. Rather, they are estimates, based upon a limited number of field samples, compared with similar data from other studies, and combined with generally accepted regional data on groundwater flow, precipitation and runoff coefficients.

Volumes of water constituting the various components of the yearly water budget for Lake Ronkonkoma were rounded-off so not to create any illusion as to the precison of the estimates. All laboratory analyses of the individual water quality grab samples used to arrive at average concentration values are listed in the report. When supplementary data were available from other studies, they were also listed and an explanation was made regarding their significance in evaluating the data generated specifically for this study.

Similar methodologies were used in estimating the water quality concentration values for each component of the hydrologic budget. The loads were calculated by multiplying the concentration of each parameter analyzed by the yearly volume of water attributed to each component. Thus, comparing the percentage of total load that each component of the hydrologic budget contributes to a particular parameter is probably a more appropriate evaluation than drawing inferences from the load masses viewed in isolation. For instance, groundwater underflow has been estimated to account for 40% of the total NO_3-N yearly load to the lake and only 0.5% of the total phosphorous load. On the other hand, it was estimated that runoff contains only 5% of the yearly NO_3-N load to the lake, but, 53% of the total phosphorous load.

6.3 CONCLUSION

Estimates of several important water quality inputs to Lake Ronkonkoma were derived using information from other studies on Long Island to supplement the sampling undertaken during this study which was limited due to flooding conditions. Assuredly, more precise estimates could be obtained in the future from more extensive flow measurements and water quality sampling, especially for stream dry weather and wet weather flow, pumpage from the recharge basins, and groundwater underflow.

Notwithstanding the need for additional monitoring there are conclusions that can be drawn based upon the study findings.

Table 6-9
Estimates of Yearly Water Quality Loads to Lake Ronkonkoma

COMPONENT OF HYDROLOGIC BUDGET

PARAMETER	DIRECT PRECIPITATION*	STORMWATER RUNOFF*	BASE STREAMFLOW	PUMPAGE to LAKE	GROUNDWATER UNDERFLOW	TOTAL LOAD to Lk.RONKONKOMA
TKN (g/yr)	8.24×10^5 (38%)	4.08×10^5 (19%)	4.15×10^5 (19%)	3.15×10^5 (15%)	2.0×10^5 (9%)	2.162×10^6
NH_3-N(g/yr)	2.80×10^5 (32%)	4.8×10^4 (5%)	2.85×10^5 (32%)	7.43×10^4 (8%)	2.0×10^5 (23%)	8.87×10^5
NO_3-N(g/yr)	5.04×10^5 (20%)	9.0×10^4 (5%)	3.15×10^5 (16%)	2.90×10^5 (14%)	8.0×10^5 (40%)	2.00×10^6
NO_2-N (g/yr)	1.30×10^4 (35.5%)	3.9×10^3 (11%)	1.3×10^4 (35.5%)	5.40×10^3 (15%)	1.0×10^3 (3%)	3.63×10^4
T.P. (g/yr)	7.34×10^4 (35%)	1.11×10^5 (53%)	1.55×10^4 (7%)	9.90×10^3 (4.5%)	6.0×10^2 (0.5%)	2.10×10^5
Total Coliform (MPN/year)	No Data	6.68×10^{13} (73%)	5.11×10^{12} (6%)	1.92×10^{13} (21%)	No Data	9.11×10^{13}
Fecal Coliform (MPN/year)	No Data	1.49×10^{13} (85%)	6.05×10^{11} (3%)	2.05×10^{12} (12%)	No Data	1.76×10^{13}
Fecal Strep. (MPN/year)	No Data	7.57×10^{13}	No Data	No Data	No Data	7.57×10^{13}
Volume of Water cubic meters/yr.	460,000**	300,000	500,000	225,000	200,000	1,685,000
Percent of Total	(27%)	(18%)	(30%)	(13%)	(12%)	(100%)

* Includes wet weather streamflow.

** Gross volume used to calculate loads is $1,440,000^3$. Net volume to lake each year is $460,000^3$ after evaporation is deducted.

The component of the water quality inputs that can be most effectively controlled or diverted from the lake is stormwater runoff. It appears that dramatic reductions in total phosphate and bacterial loads to the lake could be achieved by reducing runoff. This can be accomplished by a number of structural improvements within the watershed of the lake. They include, but are not limited to, the construction of curbing, storm sewers with leaching catch basins and recharge basins.

Reduction of loads supplied to the lake from direct precipitation, base stream flow, and groundwater underflow would be much more difficult, if not impossible.

Estimates developed in this study indicate that pumpage may not have a major water quality impact upon the lake compared to the other inputs. Regardless of any quality or quantity impacts, present control options are limited. Any deviation from the present mode for controlling pumpage from the recharge basins may have adverse consequences. If storage at the recharge basins were to be increased, by raising the water level at which pumping starts, the houses served by the recharge basins might be threatened by high water table conditions. Increasing the storage in the bog may only exacerbate the flooding problem in that vicinity. Diverting the discharge elsewhere has previously been discounted as environmentally and economically unfeasible.

Chapter 7....

Recommendations

7.1 INTRODUCTION

The purpose of the recommendations is to

- improve the Lake Ronkonkoma water quality
- preclude any inappropriate development within the lake watershed area
- protect and maintain the natural environment of the area and
- enhance the park system of Lake Ronkonkoma

7.2 LAND USE AND ZONING CONTROLS

7.2.1 Land Use. The proposed Land Use Map identifies the major land use recommendations for the Lake Ronkonkoma watershed area including the proposed land uses for the privately owned vacant properties (See Figure 7-1).

7.2.2 Zoning. The proposed zoning changes are expected prevent or minimize the discharge of additional stormwater runoff to the lake, thus reducing bacterial and other pollutant loads to the lake. This can be achieved in part by prohibiting the establishment of certain uses, i.e. high density residential and commercial uses in the area, through zoning. The changes are also expected to provide for future development that is consistent and compatible with existing development and future park plans for the area.

The following zoning recommendations have been proposed for the Lake Ronkonkoma watershed which should be classified as the Lake Ronkonkoma Watershed Zoning District (See Proposed Zoning Map - Figure 7-2):

- All vacant lands zoned for commercial and multifamily uses that are surrounded by single family residential use should be upzoned to zoning classifications consistent with the surrounding single family zoning classification. (See Municipalities)
- Prohibit the conversion of existing uses to higher intensity uses (i.e., expansion of existing facilities, conversion of single family residential to two family, or higher residential densities.)
- Upzone all public and quasi-public owned lands to the lowest density residential category within the town.
- Prohibit further expansion of any multifamily use and/or nursing home within the estimated stormwater and groundwater contributory area of the lake. (The suggested Lake Ronkonkoma Watershed Zoning District.) The towns should include a policy statement to this effect in their respective zoning codes.
- Reclassify strip commercial or other commercial zones in areas where residential land use prevails, in order to assure consistency with the surrounding area. The commercial uses would then become non-conforming uses and expansion would be prohibited.

MUNICIPALITIES

The towns should implement the following zoning changes.

Smithtown

- Upzone those vacant parcels that are currently in a high density residential zoning category and are located in a high water table area adjacent to the Lake Ronkonkoma Watershed Zoning District by reclassifying them to half acre residential. (See Figure 7-2 for location).
- Upzone undeveloped areas that are currently experiencing flooding. (See Figure 7-2).

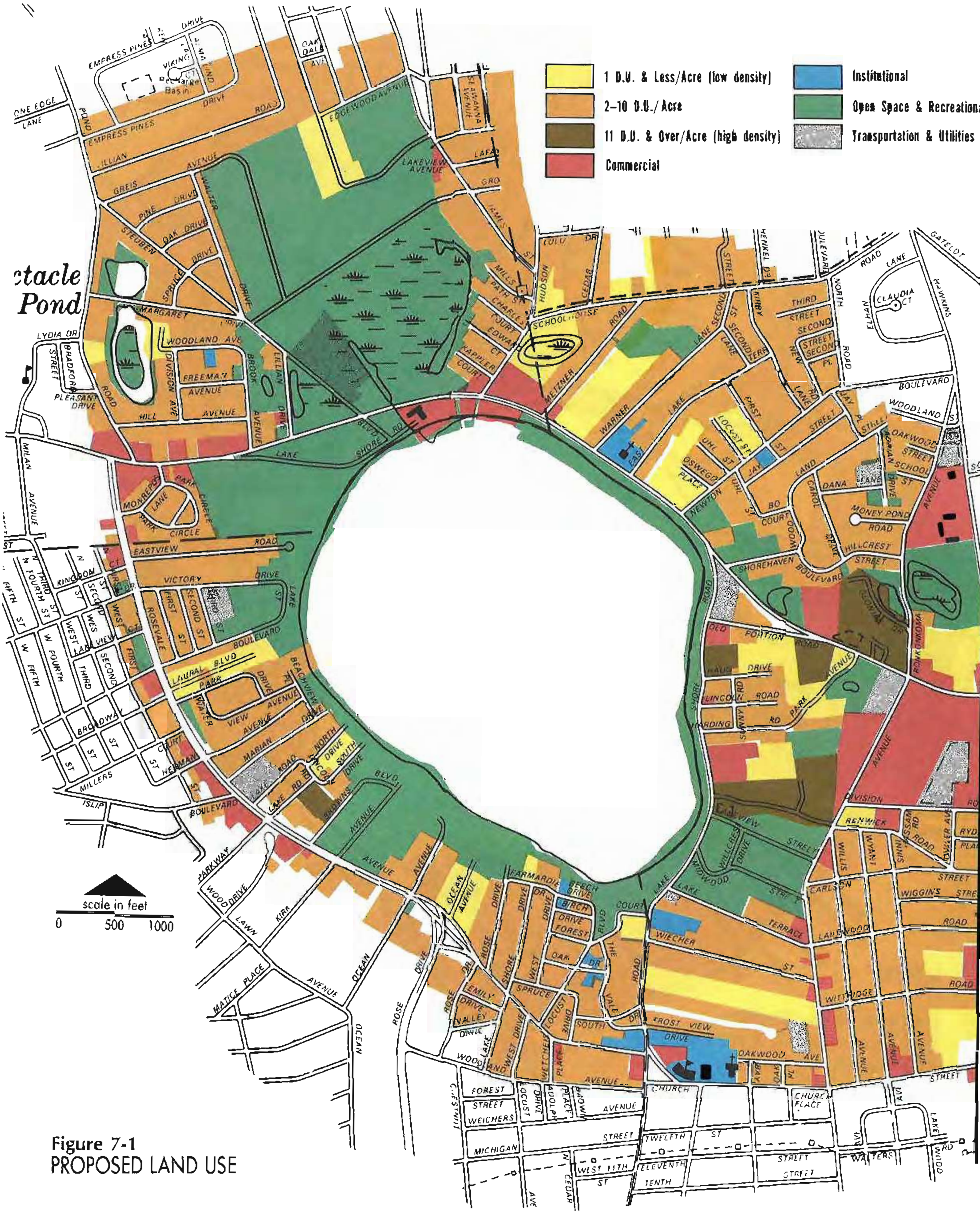


Figure 7-1
PROPOSED LAND USE

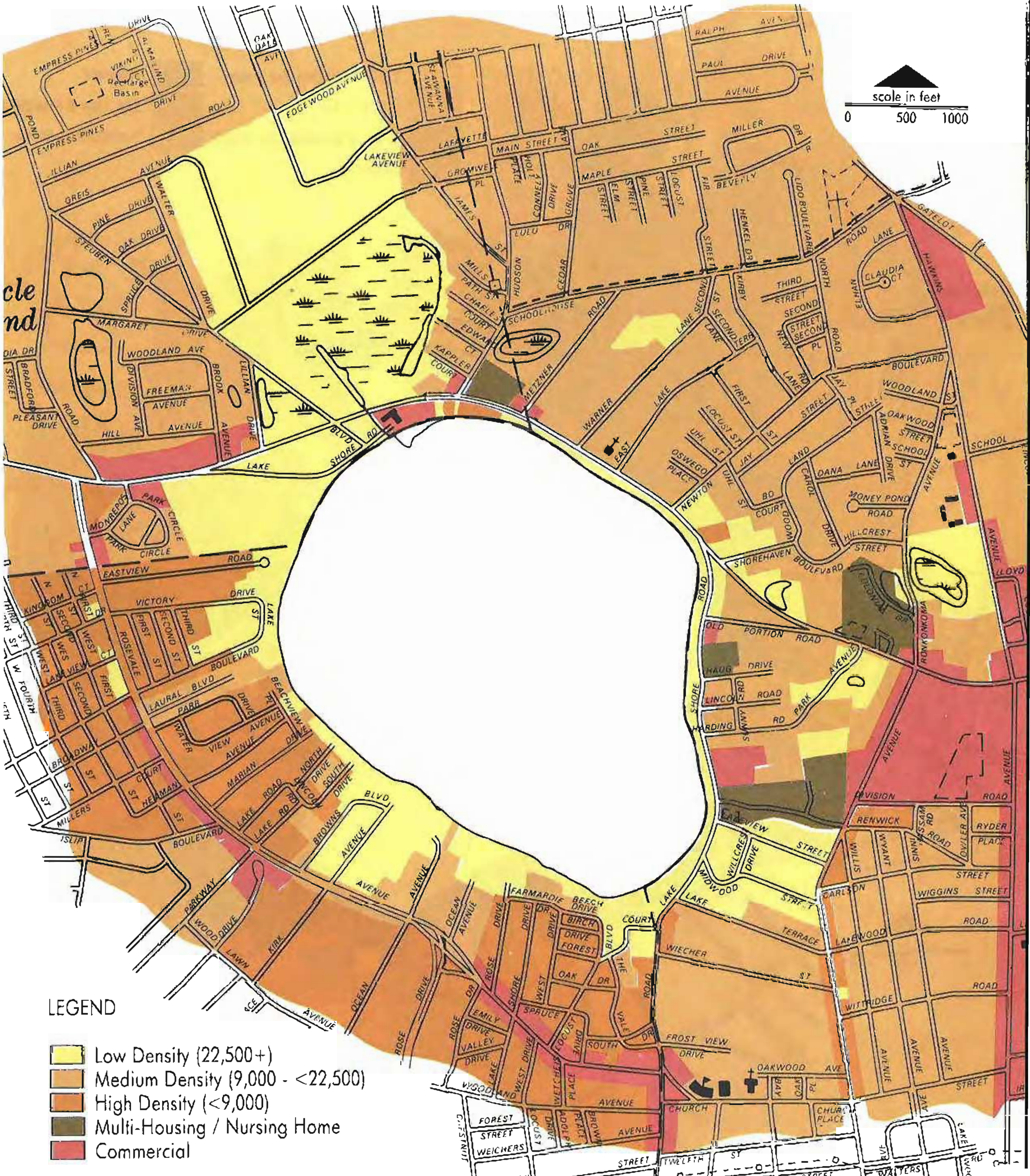


Figure 7-2
PROPOSED ZONING

- Rezone the predominantly residential portion of Smithtown Boulevard that is currently commercially zoned, in areas where the land use is predominantly residential to a medium density residential category. (See Figure 7-2 for location).
- Upzone large undeveloped parcels to preclude any additional impacts on lake water quality. Encourage clustering wherever feasible to insure the preservation of natural areas. (See Figure 7-2).
- Upzone vacant commercially zoned land by reclassifying it from the neighborhood business to shopping center which is a generally more restrictive category. (see Figure 7-2 for location).

Islip

- Rezone existing commercially zoned lands that are predominantly in residential use to a residential classification consistent with the surrounding area (see Figure 7-2 for location). Note: The Town Board rezoned ten properties totaling 4.5 acres, directly adjacent to the south side of Lake Ronkonkoma.
- Rezone an existing commercial land use located directly adjacent to the lake by placing it in a residential category consistent with the surrounding area. This use would then become a nonconforming use. (See Figure 7-2 for location).

Brookhaven

- Rezone existing commercially zoned lands that are predominantly in residential use to a residential classification consistent with the surrounding area (See Figure 7-2 for location).

7.3 FUTURE ACQUISITIONS

1. Acquire additional lands adjacent to the lake. These lands should be acquired as a part of Phase III of the acquisition process. The properties listed in Table 7-1 and shown in Figure 7-3 should be acquired.
2. Acquire the remaining sections of Steuben Blvd. not presently owned by the County for park maintenance purposes only.
3. Once acquired, transfer the following properties, #3 in Phase II and #7 in Phase III, into the County General Purposes category, so that these properties may be maintained by the Suffolk County Department of Public Works and used for stormwater runoff control.
4. Acquire wetlands parcels in single and separate ownership located adjacent and east of the Great Bog.

7.4 RIGHT OF FIRST REFUSAL.

The County should obtain the right of first refusal on all remaining privately owned properties adjacent to the lake.

7.5 WATER QUALITY MANAGEMENT THROUGH STORMWATER RUNOFF MANAGEMENT

7.5.1 County

- Suffolk County Department of Health Services should evaluate whether increased post storm monitoring should be undertaken at the town swimming beaches located on the lake.

Table 7-1
Phase III - Acquisition at Lake Ronkonkoma

TAX MAP No.	CURRENT OWNER	ACREAGE	RECOMMENDED AGENCY OWNERSHIP
1. 0800-171-06-013.00	Privately owned	0.40	Parks Department
2. 0500-022-01-009.00	Privately owned	0.30	Parks Department
3. 0500-022-01-075.003	Privately owned	1.40	Parks Department
4. 0500-022-02-048.00	Privately owned	1.00	Parks Department
5. 0800-171-5-	Town of Smithtown (Roadbed of Steuben Boulevard South of CR16)	0.36	Parks Department
6. 0800-171-2-	Town of Smithtown (Remaining town-owned roadbed of Steuben Blvd. North of CR16)	1.13	Parks Department
7. 0200-724-1-28 0200-724-1-p/o 31 0200-724-1-p/o 32	Town of Brookhaven	0.85	Public Works
		6.24	

- Suffolk County Department of Public Works should install a sedimentation pond and/or ecological recharge basin in the area northwest of the lake (east of Steuben Blvd.) and adjacent to the Great Bog where treatment and storage of stormwater is required (see Figure 7-4). No sediment or stormwater from this basin should be permitted to reach the Great Bog during the construction period or as a result of the development of this project.
- Suffolk County Department of Public Works should investigate the feasibility of discharging stormwater runoff into recharge basins, including one existing basin and one under construction (as of September 1985), located near the lake. This will prevent lake erosion due to stormwater runoff and will reduce pollutant loads to the lake. (See Figure 7-5 for the locations).
- Abandon the existing biofiltration ponds located in the Towns of Islip and Brookhaven, since they do not serve large watershed areas, do not function as originally planned, and have deteriorated.
- Suffolk County Parks Department should regrade the Islip biofiltration pond to create a gentle slope similar to adjacent shoreline areas and plant additional vegetation to prevent erosion.
- Suffolk County Parks Department should fill in existing surge tanks at the Brookhaven biofiltration pond and if possible divert stormwater into the recharge basin to be located in the Portion Road triangle or divert the pipe directly into the pond. If this is not possible, the runoff could be allowed directly into the pond from the very small drainage areas served by this storm sewer.

7.5.2 The NYSDEC, County and Municipalities

- Prohibit any new direct stormwater runoff discharges into Lake Ronkonkoma, the Great Bog, or other freshwater wetlands which may result from new development in the area.
    - Wherever possible eliminate direct discharges (stormwater runoff outfalls) into the lake through the installation of storm drain systems with a discharge into new or existing recharge basins, or other alternative structures.
    - Wherever the installation of recharge basins is not possible, prevent existing cases of overland runoff from entering the lake through the installation of curbing and clusters of leaching catch basins.

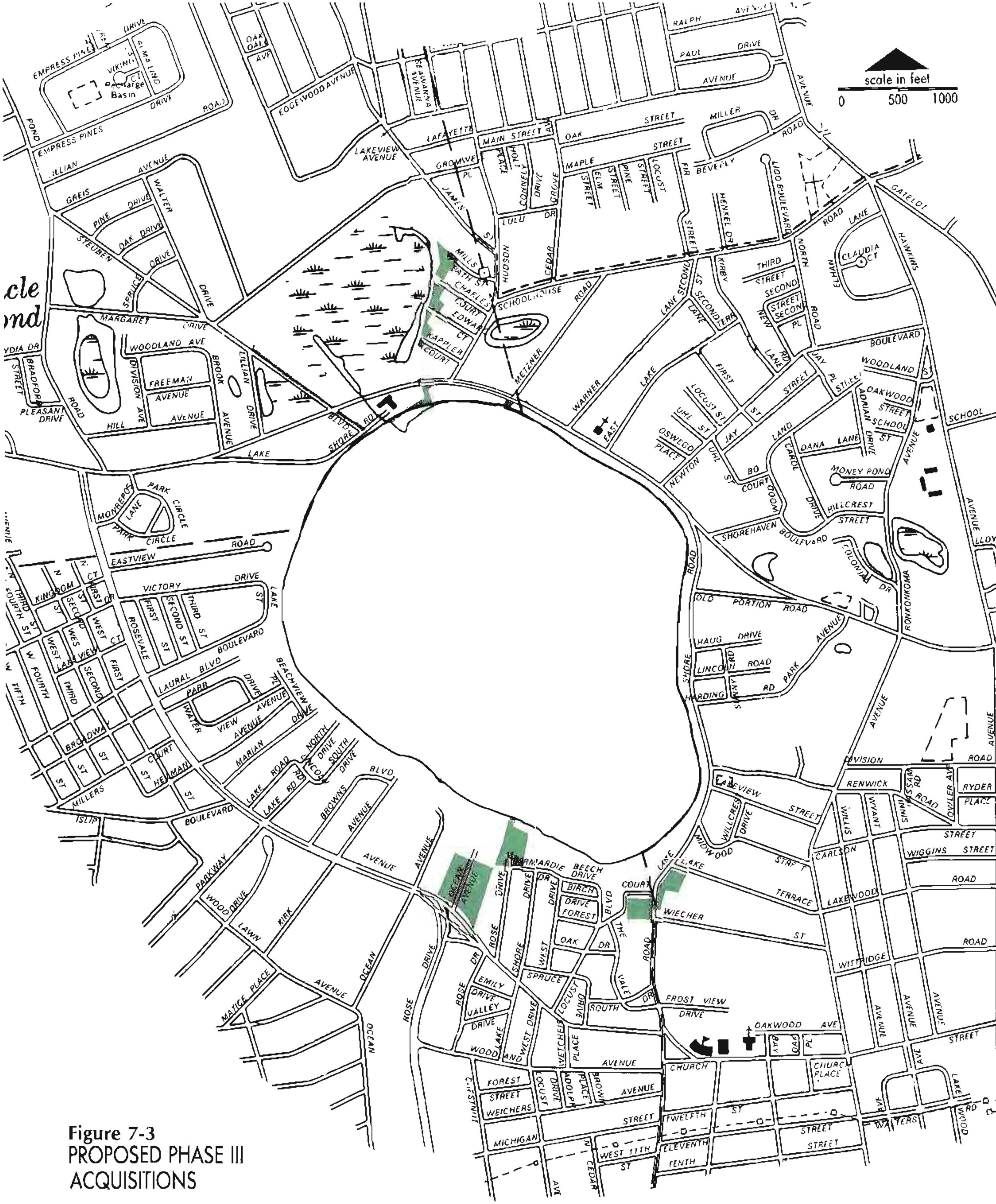


Figure 7-3
PROPOSED PHASE III
ACQUISITIONS

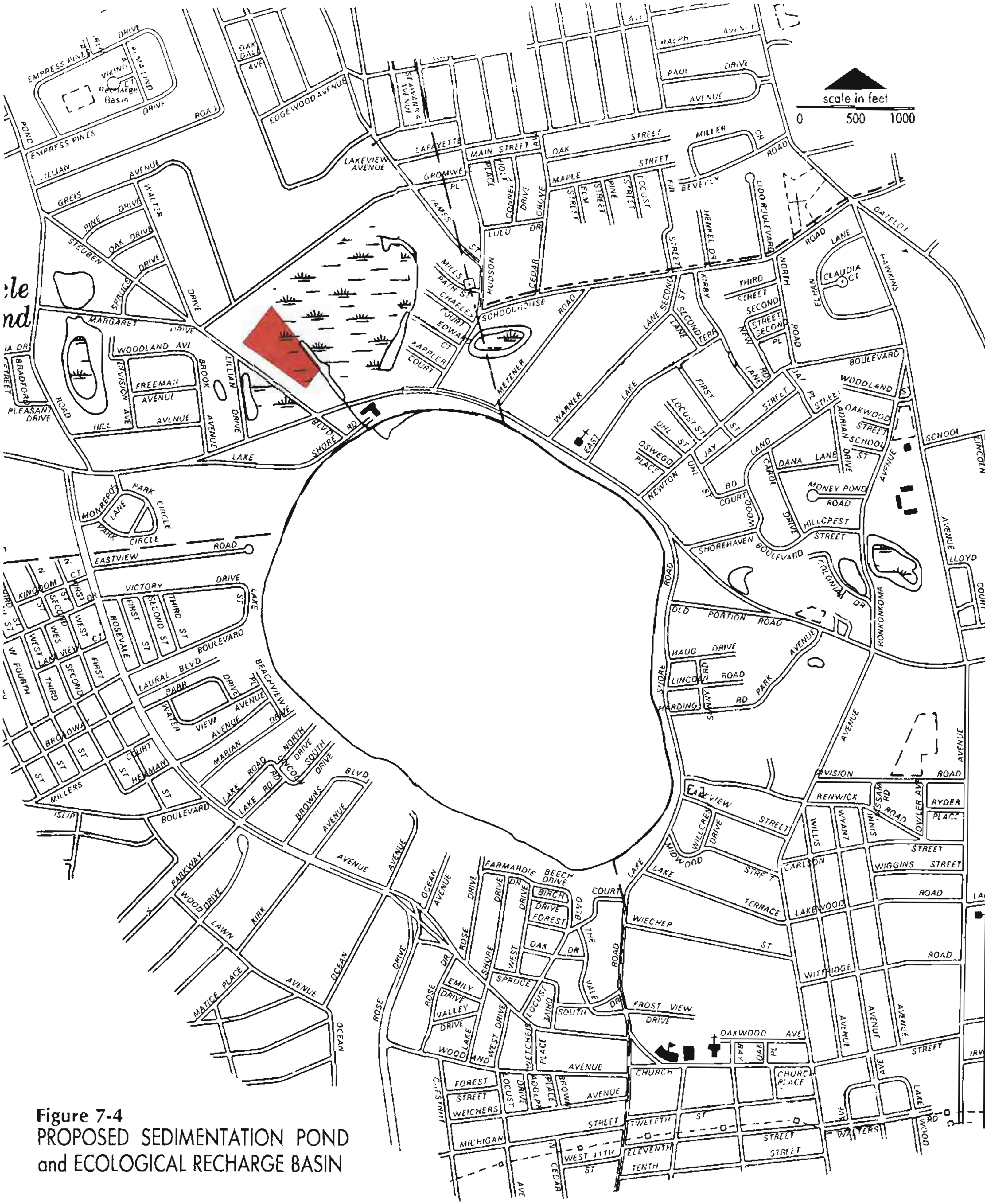


Figure 7-4
PROPOSED SEDIMENTATION POND
and ECOLOGICAL RECHARGE BASIN

Figure 7-5
LOCATION of EXISTING and PROPOSED RECHARGE BASINS

- Improve grading and install plantings on public parkland to control stormwater runoff and minimize erosion and sedimentation. Vegetation plantings can serve other purposes too: discourage the use by the public of environmentally sensitive areas and serve as cover and as a food source for wildlife.

County and the Town of Brookhaven

- Install curbs, gutters, upgrade and extend the stormwater drainage system along Lake Shore Road near the Brookhaven Town Beach in order to direct runoff from watershed area **A** away from the beach. (see Figure 7-6). (The present drainage system has a discharge pipe and concrete sluiceway located adjacent to the north side of Brookhaven Town Beach.) Connect the drainage system to a new discharge pipe to be located approximately 300 feet north of the existing discharge pipe. The exact location should be determined by the Suffolk County DPW and the Town. Remove the existing discharge pipe, concrete sluiceway and road drains adjacent to Brookhaven Town Beach.
- Install a recharge basin near the southeast corner of the lake adjacent to the east side of Lake Shore Road on Town owned property (Lake Shore Road and Lake Terrace) in order to reduce the loads from fecal coliform, and other pollutants from stormwater now being discharged into the lake directly north and next to the Brookhaven Town Beach. (see Figure 7-6). Most likely, this recharge basin will not be large enough to contain the design storm; therefore, an overflow into the lake will be necessary. This overflow can be interconnected to the proposed Lake Shore drainage system. The drainage system should be implemented whether or not the recommended recharge basin is constructed.

7.5.3 General Stormwater Management Recommendations. The following recommendations comprise preventive measures that can be used to minimize stormwater runoff contamination of the lake and groundwater resulting from site development and future land use activities. Suggestions are also provided for reducing or eliminating existing impacts and for the selection and installation of appropriate stormwater control measures including both nonstructural and structural techniques. In addition to the recommendations provided below, the Appendix describes a number of management techniques including stormwater management requirements, site planning procedures, sedimentation and erosion control measures and the suitability of these measures for various types of site conditions. The County, Municipalities and private developers within the Lake Ronkonkoma Watershed Protection District should utilize the following stormwater recommendations when undertaking any future site work that includes grading or the installation of paved surfaces(See Figure 7-7).

STATE, COUNTIES AND MUNICIPALITIES

- Limit development and the establishment of impermeable paving on publicly-owned lands located near surface waters and wetlands.
- Do not remove recharge basin vegetation since plant growth generally enhances infiltration. The root systems keep the soil layer loose and permeable and provide for the infiltration of water.
- Incorporate the erosion control recommendations, provided in the Appendix,into each site development plan for parcels within the Watershed Protection District.
- Require adherence to the following performance standards for all new site development:
    - Protect and maintain the natural functioning of the site by maintaining the absorptive, purifying and retentive functions that existed on the site before construction began.

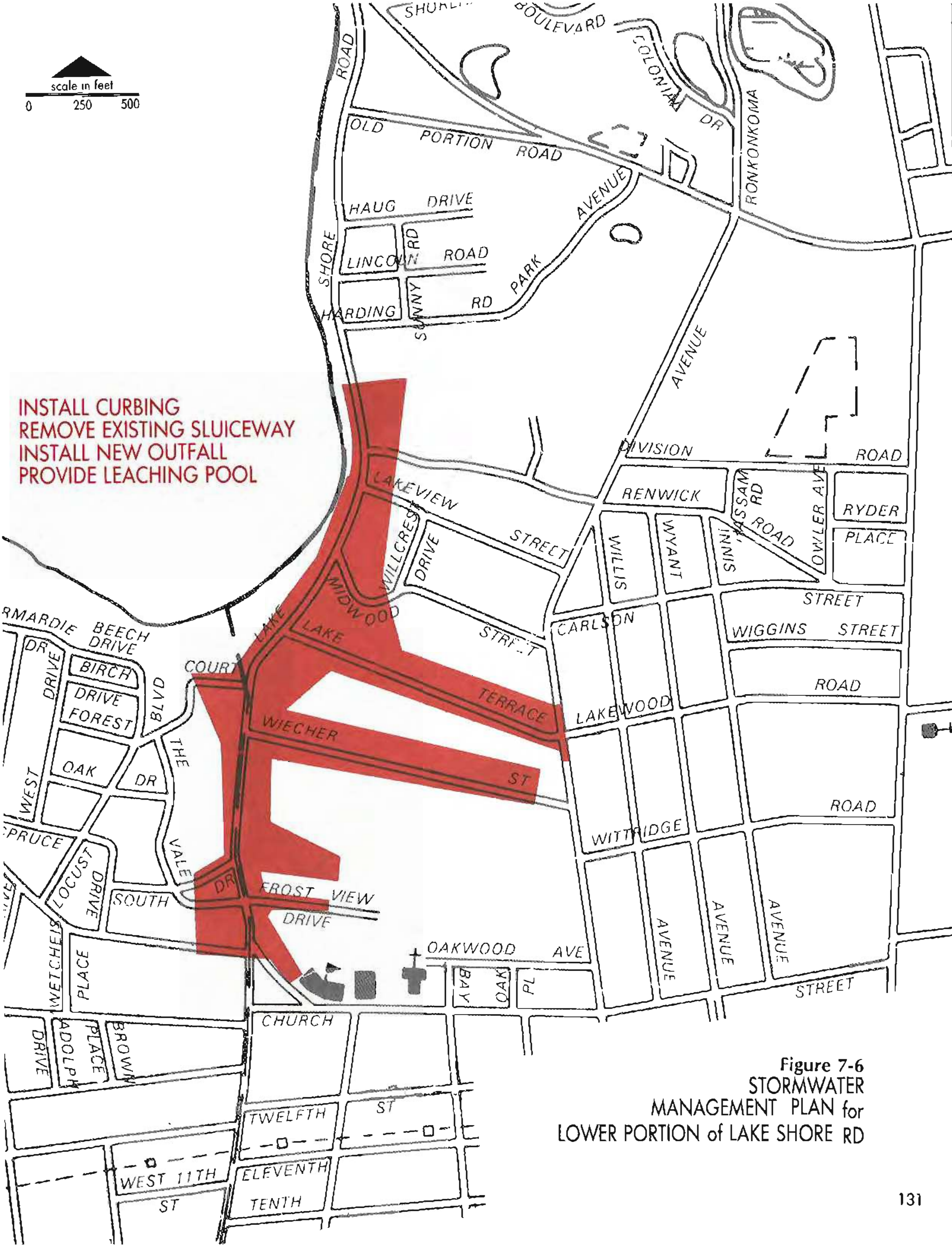


Figure 7-6
STORMWATER MANAGEMENT PLAN for LOWER PORTION of LAKE SHORE RD

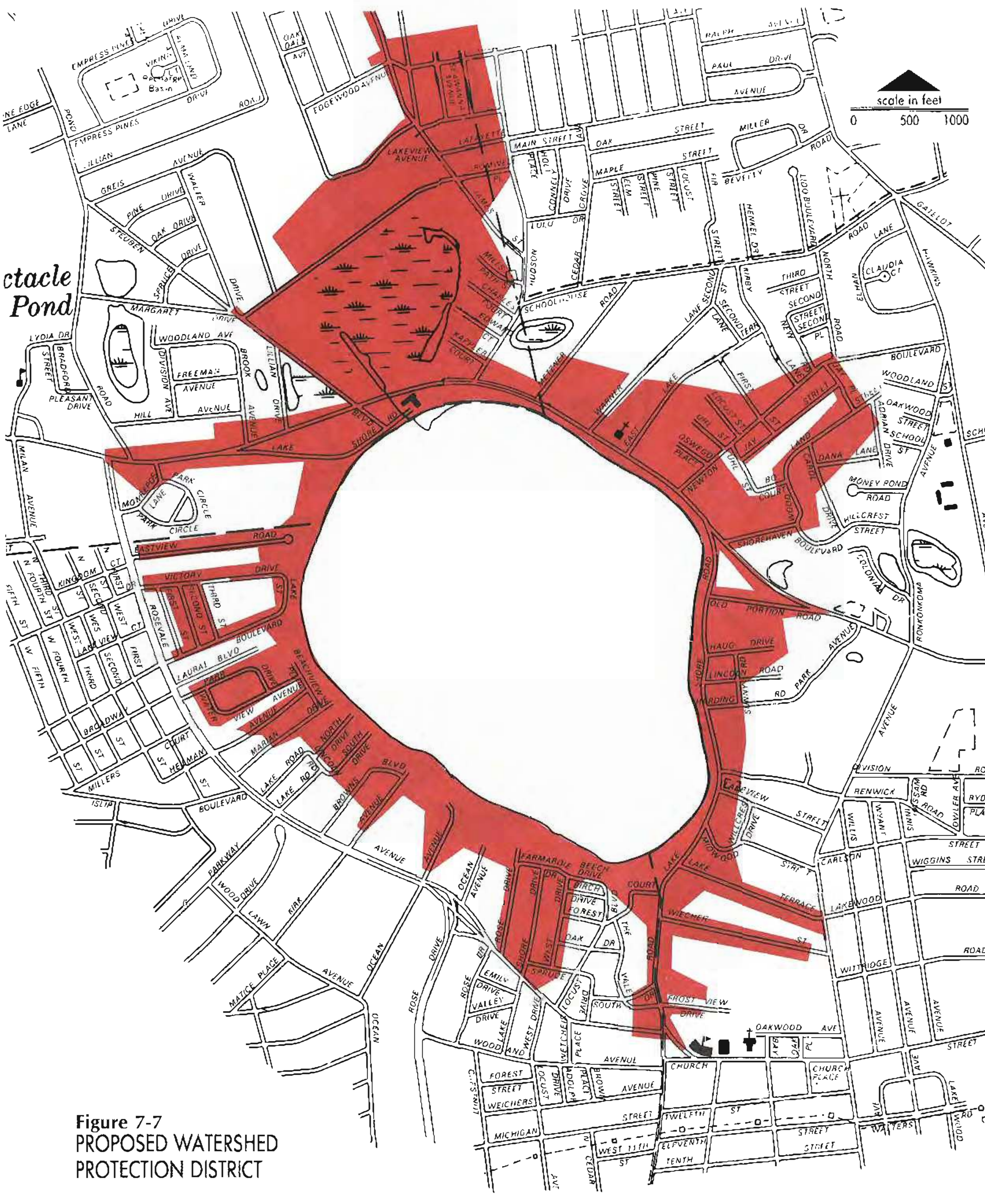


Figure 7-7
PROPOSED WATERSHED
PROTECTION DISTRICT

- Limit the post-construction volume and rate of runoff leaving the site to that calculated on the basis of natural or predevelopment conditions. The peak release rate of stormwater from all developments where retention is required for the designed storm, should not exceed the peak stormwater runoff from the area in its undeveloped state for a storm of any intensity up to and including the 100 year frequency, and for rainfall of any duration. Calculations of the rate should be based upon an assumed runoff coefficient of 0.20, 0.25, and 0.35 for average slopes of 2 percent, 2-7 percent and over 7 percent, respectively.
- Limit the release rate for drainage systems serving new development. The volume and velocity of runoff discharged should not exceed the safe capacity of the existing drainage systems into which the discharge flows.

7.6 SEPTIC SYSTEM MANAGEMENT

General

Stress the importance of the proper maintainance of existing septic sytems. Owners of septic systems should follow the guidelines listed in Appendix E.

7.7 PARKLAND AND FACILITIES MANAGEMENT

1. The Suffolk County Departments of Parks and Public Works should preserve County owned parcels that are presently undeveloped in order to protect plant and animal species and to prevent erosion (See Figure 7-8). The Parks Department should implement proposals 2 through 20.
2. Prohibit public use of the bog area as it is a fragile resource that cannot withstand extensive usage (See Figure 7-8).
3. Provide a two, three and four wheel vehicle barricade at each potential entrance to the Great Bog and the woodland area to the north of the Bog and on all steep slopes within the park system (See Figure 7-9).
4. Prevent future erosion of steep slopes and other county owned properties through the installation and maintenance of vegetation and other erosion control measures. Install additional plantings on the bank along Lake Shore Road and on the slopes at site B to prevent access and minimize further erosion. Rosa rogusa, and Berberis are recommended. See Figure 7-8 and 7-11 for location.
5. Provide on-site retention of all stormwater runoff resulting from parkland development to prevent the release of stormwater runoff from County-owned parklands into the Great Bog or to the Lake.
6. Encourage the utilization of berms and other diversion methods on park properties to provide visual and noise barriers, and to control stormwater runoff.
7. Evaluate the necessity for fencing of county properties in order to prevent unauthorized uses from occurring on these sites (See Figure 7-8).
8. Once the Kirk property is acquired, require replanting of disturbed areas and the implementation of best management practices (See Nonpoint Source Management Handbook, Long Island Regional Planning Board, 1984). Construct a temporary fence on the Kirk property adjacent to the property on the east. This fence should be removed once the County acquires the two adjoining properties to the east of the Kirk Estate.
9. Prohibit the use of Steuben Blvd. as an access road to areas north of the lake. Construct a physical barrier to insure that the road is not used. This will also prevent access for dumping which has taken place in the past (See Figure 7-8).
10. The County should hire park rangers to patrol the area as necessary in order to prevent unsupervised use of parklands and to deter vandalism.

11. Due to the erosion resulting from wave action and fluctuation in lake levels, the construction of a boardwalk adjacent to the lake beneath Lake Shore Road is not recommended. A upland walkway should be provided.
12. Implement the park plans for Development Sites **A** and **B** (See Figures 7-10, 7-11).
13. Limit the use of the sunfish sailboat launch located on Site **A** (the Commerdinger property) to sailboats rented by the private concessionaire. All other private boat owners should be required to use the State-owned boat launch.
14. Provide a barrier of large boulders on the south side of Site **A** (Commerdinger property) in order to prevent access to two, three and four wheel drive vehicles. (See Figure 7-10).
15. Site **B** should be fenced along Ronkonkoma Ave. Vehicular access from Ronkonkoma Ave. to this site should not be permitted (See Figure 7-11).
16. Utilize three sites (1, 2 and 3) along Lake Shore Road to provide parking for 10 cars each. Provide benches and controlled access to the lake. Construct a walkway upland along the eastern side of the lake. Provide trash receptacles at these locations (See Figure 7-12).
17. Provide a post and rail barrier on the west side of the Lake Shore Road as indicated in Figure 7-12 in order to prevent unauthorized access by motor vehicles.
18. No vehicles should be allowed on parkland except on the entrance drive and in the parking lots proposed for Development Sites **A** and **B** and Lake Shore Road overlooks 1, 2 and 3. Install required barriers as needed on each park parcel to direct and restrict vehicular access. (Figure 7-12)
19. Review the traffic safety conditions at Lake Shore and Portion Roads to determine the need for intersection improvements.
20. The park should be closed at dusk unless special permission has been obtained from the Commissioner of Parks, Recreation and Conservation for special events.

7.8 FERTILIZER USE AND GENERAL TURF, PLAYING FIELD OR LAWN MAINTENANCE

COUNTY, MUNCIPALITIIES AND PRIVATE CITIZENS

Since phosphorus is a component in stormwater runoff and groundwater underflow is a source of nitrogen, implementation of turf and lawn maintenance guidelines is recommended. See Appendix E for turf and lawn maintenance guidelines.

7.9 PUBLIC PARTICIPATION

1. Increase public awareness of the lake water quality through presentation and distribution of the Lake Ronkonkoma Water Quality Study and Management Plan.
2. Encourage residents to implement the recommendations for lawn maintenance.
3. Provide the public with information regarding proper use of the park. Post signs indicating acceptable and unacceptable activities at each park property.
4. Encourage the formation of neighborhood watch groups to help control vandalism and to maintain lake shore areas.

7.10 RESEARCH RECOMMENDATIONS

Research projects, designed to provide more detailed information concerning the lake's hydrology (inflow and outflow volumes of water), should be undertaken.

1. Inflow

Groundwater underflow - Obtain more accurate estimate of the yearly volume of groundwater underflow supplying Lake Ronkonkoma. This may be accomplished by the use of a pump test, seepometers or other techniques that would be appropriate.

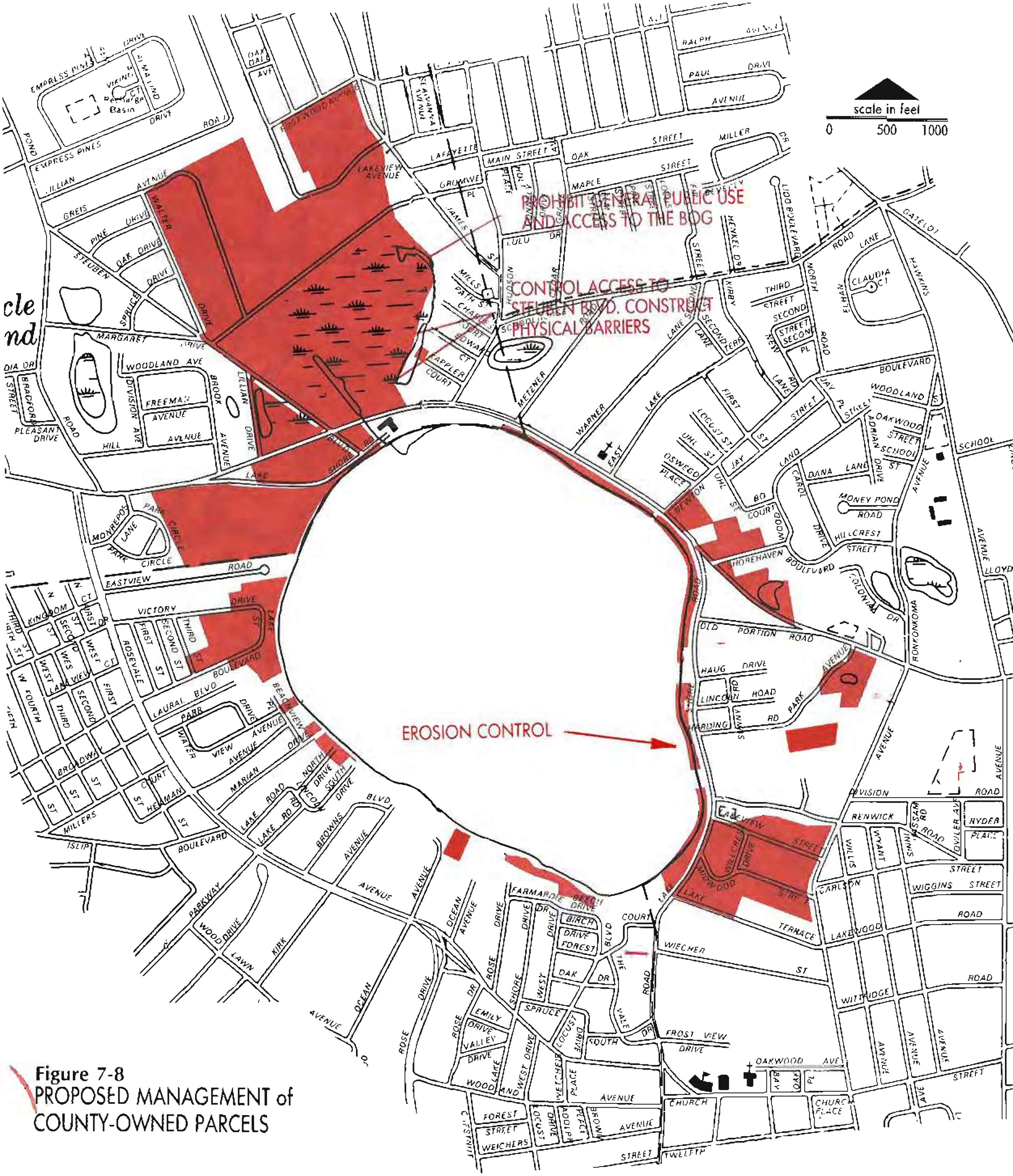


Figure 7-8
PROPOSED MANAGEMENT of COUNTY-OWNED PARCELS

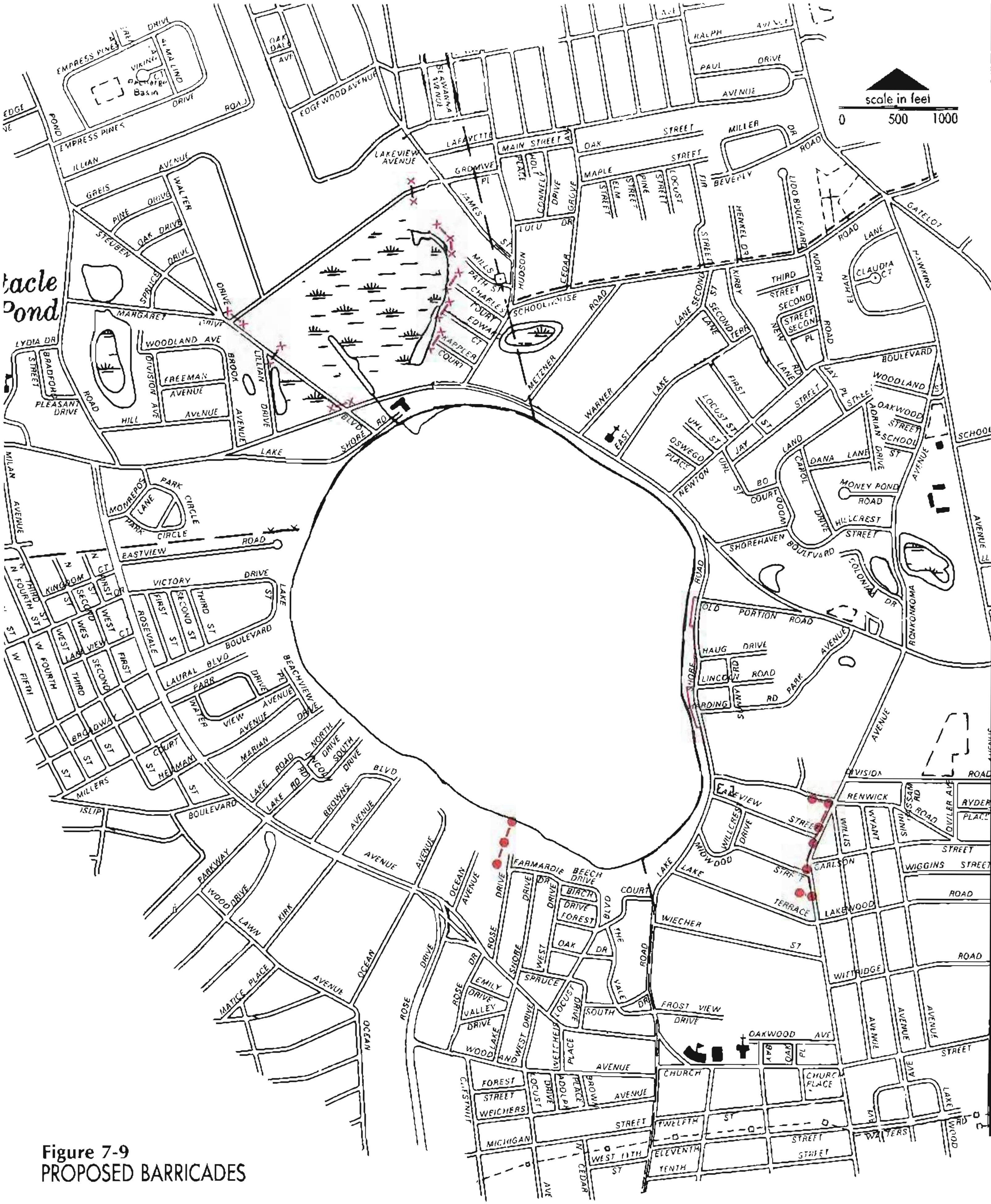


Figure 7-9
PROPOSED BARRICADES

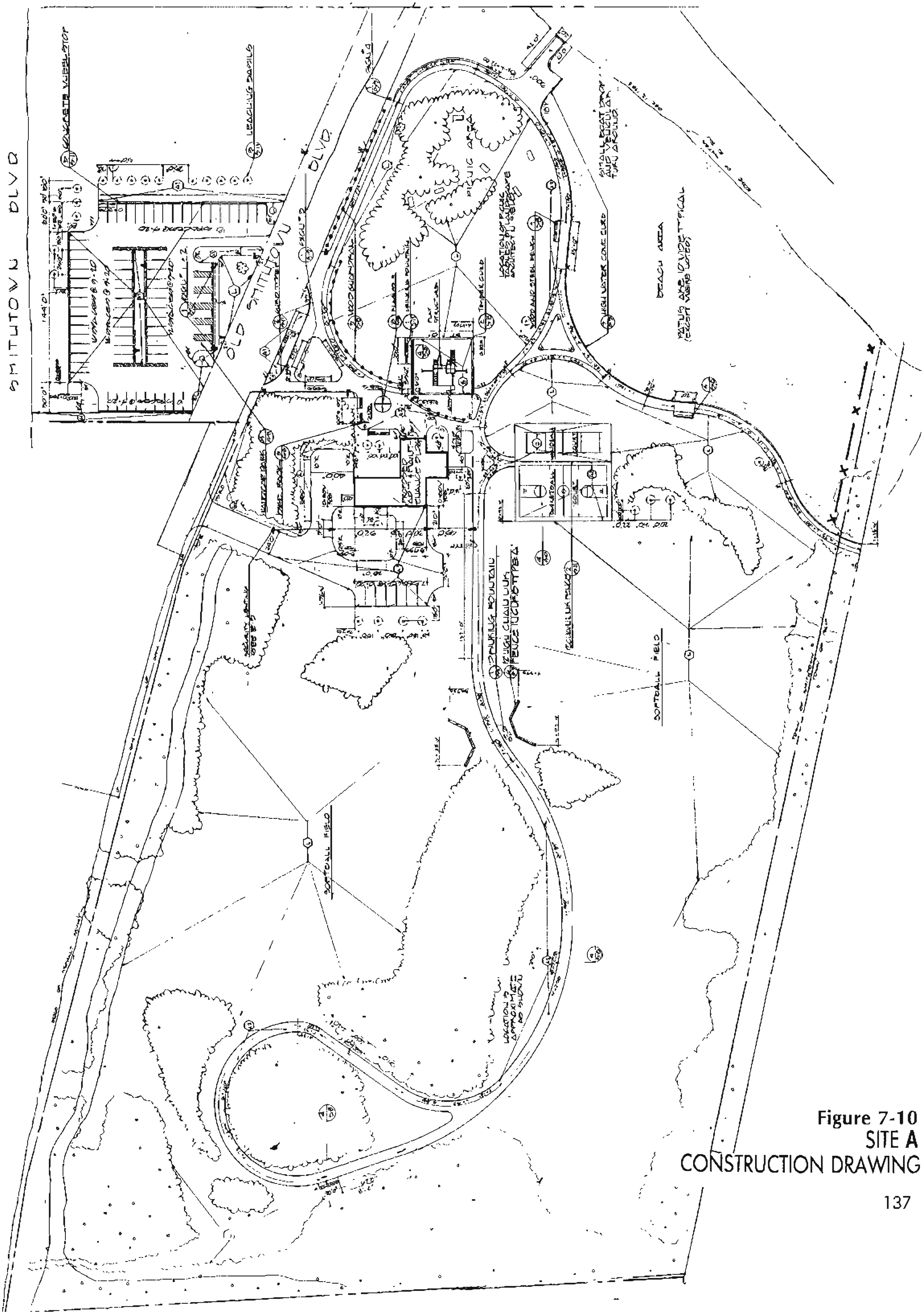
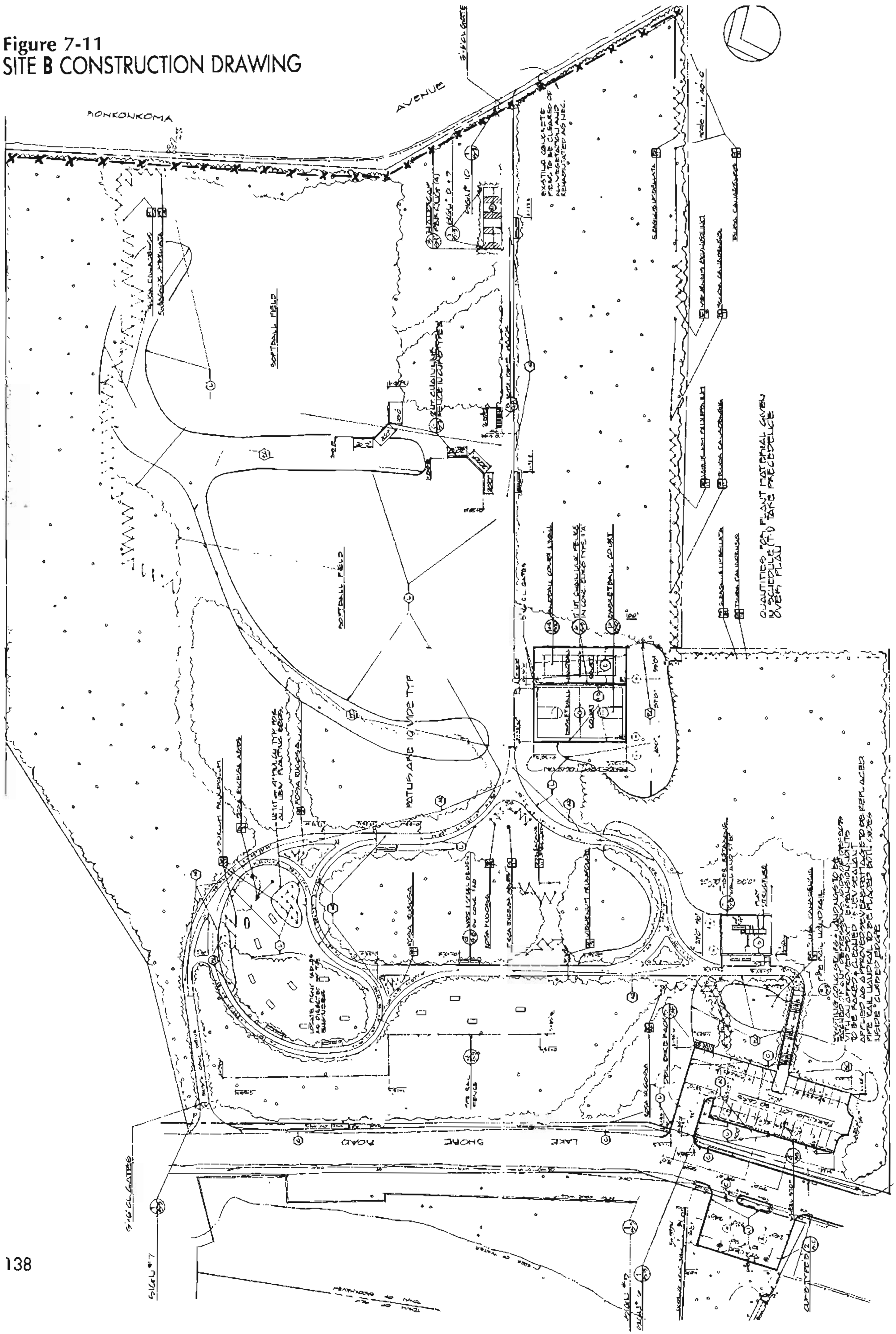


Figure 7-10
SITE A
CONSTRUCTION DRAWING

Figure 7-11
SITE B CONSTRUCTION DRAWING



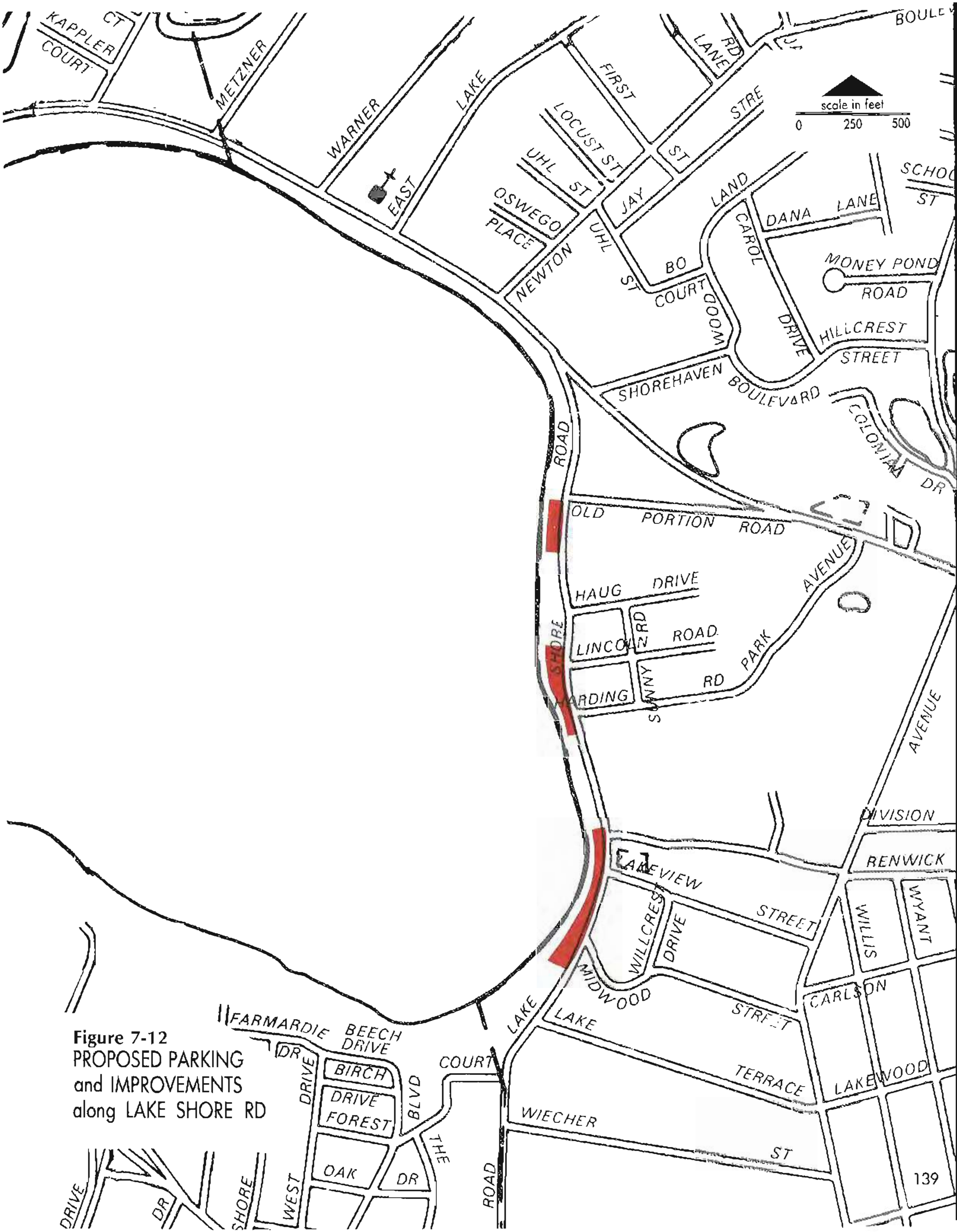


Figure 7-12
PROPOSED PARKING and IMPROVEMENTS along LAKE SHORE RD

Streamflow - Long term, intermittent gauging of the stream from the bog to the lake has been undertaken by the USGS. To supplement these data, gauging should be considered at periods preceding, during and following a rainfall. Within this same time frame, water quality samples should be collected. The data generated from this type of monitoring should assist in determining the impact from direct precipitation, stormwater runoff and pumpage upon the lake. It will also help determine if pollutants (bacteria, chemicals and sediments) are stored in the bog and introduced into the lake by the increased streamflow during rainfall conditions.

Pumpage - A flow meter should be installed at the pump station that controls the flow of water from three recharge basins to bog. Sampling should also be done to better assess the impact of the pumpage on the water quality of the bog and the lake.This can be coordinated with the previous recommendation concerning streamflow.

2. Outflow

More detailed information concerning groundwater underflow (outflow) from the lake should be obtained. This might be accomplished by exfiltration test by using a pump test combined with seepometers, controlled tracers or other types of procedures that are suitable for determining exfiltration rates.

3. Stormwater Runoff

Study the effects of stormwater runoff on the bacterial quality of the beach waters during the swimming season. Determine the concentration of bacteria in the water immediately following a rainfall and the reduction in concentration within predetermined intervals for a 24 to 48 hour period following a rainfall. This research may be useful in deciding if new restrictions on swimming (e.g., no swimming within a 24 hour period following a rainfall equal to or greater than 0.25 inches) are appropriate.

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Appendix Outline

Appendix Table A-1
Chemical Recovery, Duplicate, and Replicate Chemical Analyses Results for Water Samples
November 1982 through June 1984

		PARAMETER (mg/l)							
		NO_3-N	NO_2-N	NH_3-N	TKN	DKN	TOTAL PHOS.	DISSOLVED PHOS.	TOTAL CARBON
TYPE of SAMPLE	DETECTION LIMIT	0.02	0.001	0.05	0.1	0.1	0.002	0.002	5
Lake Split & Spike	Conc. Unspiked	0.07	0.006	0.46	0.2	0.2	0.028	0.010	10
	Conc. Spiked	0.46	0.017	0.54	1.1	0.4	0.086	0.015	10
	Theoretical Conc.	0.40	0.012	0.06	1.0	-	0.048	0.004	-
	% Recovery	98%	92%	133%	90%		121%	125%	
LR C_1 Split & Spike	Conc. Unspiked	0.53	0.017	0.62	0.3	0.4	0.058	0.022	19
	Conc. Spiked	0.91	0.027	0.68	0.9	0.2	0.123	0.019	17
	Theoretical Conc.	0.40	0.012	0.06	1.0	-	0.048	0.004	-
	% Recovery	95%	83%	100%	60%		135%	75%	
Blank & Spike	Conc. Unspiked	<0.02	<0.002	<0.05	<0.1	<0.1	0.010	0.00	2
	Conc. Spiked	0.38	0.012	0.09	0.2	<0.1	0.049	0.008	1
	Theoretical Conc.	0.40	0.012	0.06	1.0	-	0.048	0.004	-
	% Recovery	95%	100%	150%	20%		81%	50%	
Blank & Spike	Conc. Unspiked	<0.02	<0.002	<0.05	<0.1	<0.1	0.010	0.006	2
	Conc. Spiked	0.38	0.012	0.09	0.2	0.2	0.061	0.009	1
	Theoretical Conc.	0.40	0.012	0.06	1.0	-	0.048	0.004	-
	% Recovery	95%	100%	150%	20%		81%	50%	
Blank*		<0.05	0.002	<0.05	0.4	0.5	0.008	0.008	2
Blank **		<0.05	0.002	<0.05	<0.1	<0.1	0.009	0.008	1
Blank **		<0.05	<0.001	<0.05	<0.1	<0.1	0.004	<0.002	<1
Blank **		<0.02	<0.002	<0.05	<0.1	<0.1	0.010	0.006	2
Field Duplicates	A	0.22	0.005	0.05	0.4	-	0.027	0.005	9
	B	0.22	0.005	0.05	0.8	-	0.037	0.006	9
	% Difference	0%	0%	0%	50%	-	27%	17%	0%
	A	<0.02	0.002	<0.05	0.5	0.2	0.026	0.007	12
	B	<0.02	0.002	0.05	0.4	0.4	0.018	0.006	11
	% Difference	0%	0%		20%	50%	31%	14%	8%
	A	0.26	0.017	0.63	1.0	0.9	0.050	0.019	25
	B	0.25	0.016	0.64	0.8	0.6	0.037	0.022	28
	% Difference	4%	6%	2%	20%	33%	26%	14%	11%
	A	0.06	0.008	0.32	1.1	0.8	0.046	0.013	21
	B	0.06	0.008	0.33	0.8	1.0	0.034	0.014	19
	% Difference	0%	0%	3%	27%	20%	26%	7%	10%
	A	<0.05	0.002	<0.05	0.5	0.2	0.023	0.014	12
	B	<0.05	0.002	0.05	0.6	0.2	0.033	0.016	11
	% Difference	0%	0%	0%	17%	0%	30%	13%	8%
	A	0.94	0.011	0.73	0.8	0.9	0.029	0.013	14
	B	0.98	0.012	0.73	0.8	0.8	0.023	0.008	14
	% Difference	4%	8%	0%	0%	11%	21%	38%	0%
	A	0.20	0.005	0.06	0.4	0.3	0.017	0.007	9
	B	0.20	0.004	0.06	0.3	0.2	0.015	0.005	10
	% Difference	0%	20%	0%	25%	33%	12%	29%	10%

Appendix Table A-1 (Cont'd.)

TYPE of SAMPLE	DETECTION LIMIT	NO_3-N	NO_2-N	NH_3-N	TKN	DKN	TOTAL PHOS.	DISSOLVED PHOS.	TOTAL CARBON
		PARAMETER (mg/l)							
		0.02	0.001	0.05	0.1	0.1	0.002	0.002	5
Field Replicates (Splits)	*** A-1	0.07	0.006	0.37	1.2	1.2	0.035	0.018	9
	A-2	0.07	0.005	0.39	1.2	1.1	0.040	0.017	9
	% Difference	0%	17%	5%	0%	8%	13%	6%	0%
	*** B-1	0.36	0.006	0.17	0.9	0.8	0.024	0.012	6
	*** B-2	0.30	0.007	0.3	1.1	1.1	0.011	0.005	11
	% Difference	17%	14%	43%	18%	27%	54%	58%	45%
	C-1	0.2	0.004	0.1	0.7	1.0	0.019	0.010	8
	C-2	0.2	0.004	0.1	0.7	0.5	0.018	0.008	10
	% Difference	0%	0%	0%	0%	50%	5%	20%	20%
	D-1	0.38	0.006	0.10	0.6	-	0.017	0.006	8
	D-2	0.36	0.005	0.06	0.6	-	0.027	0.007	9
	% Difference	5%	17%	40%	0%		37%	14%	11%
	E-1	0.48	0.020	0.51	0.8	-	0.028	0.015	19
	E-2	0.48	0.021	0.52	0.8	-	0.035	0.014	19
	% Difference	0%	5%	2%	0%	-	20%	7%	0%
	F-1	0.02	0.006	<0.05	0.4	0.3	0.030	0.018	8
	F-2	0.02	0.006	<0.05	0.5	0.3	0.019	0.009	10
	% Difference	0%	0%	0%	20%	0%	37%	50%	20%
	G-1	<0.02	0.006	0.07	0.6	0.5	0.026	0.010	8
	G-2	0.02	0.005	<0.05	0.4	0.4	0.020	0.016	10
	% Difference		17%		33%	20%	23%	38%	20%
	H-1	<0.02	0.001	<0.05	0.2	0.2	0.022	0.006	12
	H-2	0.03	0.001	<0.05	0.5	0.4	0.018	0.010	11
	% Difference	0%	0%	60%	50%	18%	40%	8%	
	I-1	0.12	0.009	0.56	0.6	0.4	0.046	0.013	23
	I-2	0.12	0.009	0.56	1.0	0.8	0.053	0.018	22
	% Difference	0%	0%	0%	40%	50%	13%	28%	4%
	J-1	<0.05	0.002	0.06	1.2	0.5	0.026	0.011	13
	J-2	<0.05	0.002	0.06	1.0	0.4	0.029	0.012	14
	% Difference	0%	0%	0%	17%	20%	10%	8%	8%
	K-1	<0.05	0.003	0.33	1.4	1.0	0.032	0.015	13
	K-2	<0.05	0.004	0.32	1.6	1.1	0.026	0.010	12
	% Difference	0%	25%	3%	13%	9%	19%	33%	8%
	L-1	<0.05	0.003	0.61	0.9	0.6	0.032	0.012	12
	L-2	<0.05	0.003	0.61	0.6	0.5	0.036	0.008	12
	% Difference	0%	0%	0%	33%	17%	11%	33%	0%
	M-1	0.46	0.016	0.88	0.7	0.8	0.038	0.028	24
	M-2	0.46	0.016	0.87	0.8	0.8	0.042	0.025	24
	% Difference	0%	0%	1%	13%	0%	10%	11%	0%
	N-1	0.20	0.006	0.30	0.7	0.6	0.036	0.011	10
	N-2	0.20	0.006	0.31	0.8	0.6	0.026	0.011	10
	% Difference	0%	0%	3%	13%	0%	28%	0%	0%
	O-1	0.27	0.005	0.06	0.4	0.2	0.028	0.002	11
	O-2	0.22	0.005	0.07	0.3	0.2	0.018	0.005	10
	% Difference	19%	0%	14%	25%	0%	36%	60%	9%

Appendix Table A-1 (Cont'd.)

			PARAMETER (mg/l)							
			NO_3-N	NO_2-N	NH_3-N	TKN	DKN	TOTAL PHOS.	DISSOLVED PHOS.	TOTAL CARBON
TYPE of SAMPLE	DETECTION LIMIT		0.02	0.001	0.05	0.1	0.1	0.002	0.002	5
Field Replicates (Splits) (Cont'd.)		P-1	0.35	0.005	0.10	0.4	0.2	0.019	0.006	10
		P-2	0.31	0.005	0.10	0.2	0.3	0.014	0.007	10
	% Difference		11%	0%	0%	50%	33%	26%	14%	0%
		Q-1	0.09	0.006	<0.05	0.7	0.4	0.023	0.01	8
		Q-2	0.07	0.006	<0.05	0.6	0.3	0.021	0.006	8
	% Difference		22%	0%	0%	14%	25%	9%	40%	0%
		R-1	0.06	0.005	<0.05	0.6	0.2	0.031	0.022	11
		R-2	0.07	0.004	<0.05	0.3	0.3	0.024	0.006	8
	% Difference		14%	20%	0%	50%	33%	23%	73%	27%
		S-1	0.16	0.026	0.67	1.1	1.1	0.024	0.011	17
		S-2	0.19	0.027	0.69	1.1	1.2	0.022	0.017	19
	% Difference		16%	4%	3%	0%	8%	8%	35%	11%
Laboratory Replicate Analyses		1-1						0.022	0.010	
		1-2						0.025	0.010	
	% Difference							12%	0%	
		2-1	0.21	0.005	0.05					
		2-2	0.22	0.005	0.05					
	% Difference		5%	0%	0%					
		3-1	0.02	0.006	<0.05					
		3-2	<0.02	0.005	<0.05					
	% Difference			17%	0%					
		4-1	<0.02	0.002	<0.05					
		4-2	0.02	0.001	<0.05					
	% Difference			50%	0%					
		5-1	<0.02	0.001	<0.05					
		5-2	<0.02	0.001	<0.05					
	% Difference		0%	0%	0%					
		6-1	<0.05	0.002	<0.05					
		6-2	<0.05	0.002	<0.05					
	% Difference		0%	0%	0%					
		7-1	<0.05	0.004	0.61					
		7-2	<0.05	0.003	0.62					
	% Difference		0%	25%	2%					
		8-1	0.97	0.011	0.74					
		8-2	0.98	0.012	0.72					
	% Difference		1%	8%	3%					
		9-1	0.62	0.017	0.61					
		9-2	0.53	0.017	0.63					
	% Difference		15%	0%	3%					

*Distilled water - unrinsed sample bottles
**Distilled water - sample bottles rinsed 3 times with distilled water
***Sample analyses performed by NYSDOH, Albany, NY (A-1, A-2, B-1)
****Sample analyses performed by SCDHS, Hauppauge, NY (B-2)
Conc = Concentration

Appendix Table B-1.1
Summary of Sampling Field Schelule and Observations, Ambient Lake Survey

DATE	TIME of SAMPLING (Hours)	AIR TEMP (C^0)	CLOUD COVER (%)	WIND SPEED, DIR. (Mph)	OBSERVATIONS
11-9-82	1245 - 1615	11	0	7-10 NNE	Obvious odor of H_2S from LR-6 Water.
1-6-83	1230 - 1430	4.5	100	7-12 NNE	Lake water color noticeably dark green. Light rain beginning by last sampling.
2-15-83	1230 - 1445	8	0	Calm	2-3 inches of ice over entire lake, 2 days after 20 inch snowfall.
3-16-83	0930 - 1045		0	7-10 N	LR-6 water humic color, approximately 2-3 cf/s flow, strong odor of H_2S present.
5-10-83	1000 - 1155	14	0	5-10 W	LR-6 water rust color, humic odor, approximately 3-4 cf/s flow.
5-24-83	0850 - 1030	16	100, Hazy	Calm	LR-6 dark brown to black in color, flow present.
6-14-83	0800 - 0950	23	0, Hazy	Calm	LR-6 with odor of decaying organic matter, bottom covered with motts of filamentous algae, lake strewn with debris and some dead fish, insect casings abundant.
6-28-83	0900 - 1030	25	90-100, Hazy	3-4 SE	LR-6 bottom covered with lush filamentous green algae.
7-19-83	0845 - 1030	27	80-90	2-3 NNE	Surface algal bloom abundant at Brookhaven Beach; LR-6 bottom covered with filamentous algae, water color dark brown, very slight flow.
8-2-83	0830 - 1030	26	10	2-3 S	Lake water pea-green in color, wind traces of algae obvious; LR-6 water color yellow-brown with H_2S odor.
8-16-83	0745 - 0915	23	0	Calm	Lake with floating algal bloom over entire surface, abundant insect casings on surface, lake littered with beer bottles and other floating debris; LR-6 bottom scoured cleon, no H_2S odor.
8-30-83	0745 - 0915	25	70-100, Hazy	Calm	Patchy algal bloom on lake surface, heavy algal bloom at Brookhaven Beach; LR-6 water color dark brown to black, bottom overgrown with filamentous algae, water with H_2S odor.
9-27-83	0745 - 1015		0	Calm to 2-5 NNE	Blue-green algal bloom heavy on lake surface, several hundred gulls present; LR-6 water clear and dark brown in color, bottom covered with heavy filamentous algal growth.
11-1-83	0745 - 1030	15	0	Calm	Lake water noticeably green in color; LR-6 bottom clear of algae, no H_2S odor.
11-21-83	0900 - 1015	Falling, <15	100	15-20 N	2-3 ft. chop on lake; LR-6 very turbid with > 10 cf/s flow.
12-20-83	0730 - 0915	-9	30	12-15 N, Gusting	LR-6 water brown in color, clear, no perceptable flow, lines and samplers freezing.
3-20-84	0800 - 1000	6	95	10-12 N	Lake level very high; LR-6 over bank, no perceptible flow.
4-10-84	0815 - 1000	4	70-80	10-15 NNE	Lake level high, shoreline erosion obvious and severe.
5-7-84	0710 - 0930	14	5	Calm	LR-6 water dark brown to black in color, very slight flow.

Appendix Table B-2.1
Chemical and Biological Data - Ambient Lake Survey

DATE	STATION	DEPTH	*NO_3-N	NO_2-N	NH_3-N	TKN	DKN	TP	SP	TC	DO	TEMP (C°)	pH	COND. µS/cm²	ALKALINITY mg/l $CaCO_3$	TOT COL. MPN/100 ml	FEC. COL. MPN/100 ml
11-9-82	LR-1	1 m	0.10	<0.005	0.37	1.20	0.96	0.045	0.017	10	9.8	13.0	6.4	210	20		
		12 m	0.06	<0.005	0.43	1.20	1.00	0.037	0.012	9	7.9	11.5	6.4	190	21		
		18 m	<0.05	<0.005	1.10	2.10	1.60	0.053	0.025	8	0.5	10.0	6.3	225	33		
	LR-2	1 m	0.07	0.006	0.36	1.20	0.98	0.040	0.014	10	9.9	12.2	6.75	190	22		
	LR-3	1 m	0.07	0.005	0.37	1.20	0.96	0.040	0.013	9	9.4	12.0	6.5	200	19		
	LR-4	1 m	1.20	0.013	0.55	0.84	0.84	0.029	0.010	6	9.8	12.5	6.5	160	21		
	LR-5	1 m	1.30	0.013	0.54	0.97	-	0.041	0.010	7	9.8	12.2	6.3	200	21		
	LR-6	Subsurface	0.07	0.005	0.39	1.20	1.10	0.040	0.017	9	5.7	10.5	5.9	255	20		
1-6-83	LR-1	1 m	0.30	0.007	0.30	1.10	1.10	0.011	0.005	11	11.8	4.0	6.9	140	15		
		19 m	0.30	0.007	0.30	1.30	1.10	0.011	0.005	11	7.6	4.0	6.2	144	25		
	LR-6	Subsurface	2.00	0.017	0.70	1.10	0.95	0.010	0.005	14	7.6	4.5	6.9	182	15		
2-15-83	LR-1	1 m	0.20	0.004	0.10	0.65	0.95	0.019	0.010	8	14.6	0.0	6.0	141	10		
		5 m	0.20	0.004	0.10	0.60	0.40	0.023	0.012	10	13.5	0.0	5.9	141	10		
	LR-6	Subsurface	1.90	0.029	0.90	1.00	0.90	0.035	0.022	16	3.5	1.5	5.6	228	19		
3-16-83	LR-1	1 m	0.38	0.006	0.10	0.60	-	0.017	0.006	8	11.8	6.0	6.4	134	12		
		18 m	0.37	0.006	0.08	0.70	-	0.022	0.005	9	12.0	6.0	6.3	132	13		
	LR-2	1 m	0.37	0.005	0.08	0.40	-	0.019	0.005	10	11.9	6.0	6.2	147	14		
	LR-3	1 m	0.38	0.005	0.06	0.70	-	0.026	0.005	9	12.1	6.0	6.3	146	14		
	LR-4	1 m	0.38	0.004	0.05	0.40	-	0.017	0.005	10	11.9	6.0	6.25	147	14		
	LR-5	1 m	0.37	0.004	0.06	0.60	-	0.019	0.006	9	12.0	6.0	6.15	146	14		
	LR-6	Subsurface	1.20	0.014	0.35	1.60	-	0.013	0.006	12	6.8	8.5	6.0	152	21		
5-10-83	LR-1	1 m	0.22	0.005	0.05	0.4	-	0.027	0.005	9	10.1	15.5	6.6	124	13		
		15 m	0.24	0.005	0.28	0.5	-	0.023	0.009	8	6.4	8.8	6.5	127	15		
	LR-2	1 m	0.22	0.005	0.05	0.6	-	0.034	0.011	8	10.4	15.0	6.6	133	13		
	LR-3	1 m	0.23	0.005	0.05	0.7	-	0.042	0.014	8	10.5	15.5	6.6	125	13		
	LR-4	1 m	0.23	0.005	0.05	0.4	-	0.022	0.002	9	10.4	15.5	6.7	127	13		
	LR-5	1 m	0.23	0.004	<0.05	0.5	-	0.035	0.009	9	10.4	15.5	6.7	130	13		
	LR-6	Subsurface	0.52	0.013	0.36	0.8	-	0.021	0.007	15	4.3	14.5	6.7	162	20		

Appendix Table B-2.1 (Cont'd.)

DATE	STATION	DEPTH	*NO_3-N	NO_2-N	NH_3-N	TKN	DKN	TP	SP	TC	DO	TEMP (C°)	pH	COND. $\mu S/cm^2$	ALKALINITY mg/l $CaCO_3$	TOT COL. MPN/100 ml	FEC. COL. MPN/100 ml
5-24-83	LR-1	1 m	0.19	0.006	0.05	0.5	-	0.029	0.016	9	10.0	15.0	6.7	124	18	40	40
		15 m	0.26	0.005	0.24	0.6	-	0.015	0.007	9	2.6	8.0	5.4	116	15	<30	<30
	LR-2	1 m	0.18	0.006	<0.05	0.4	-	0.042	0.008	9	10.2	16.0	6.8	116	15	<30	<30
		3 m	0.19	0.005	0.05	0.4	-	0.026	0.007	9	8.9	14.5	6.2	115	13	40	<30
	LR-3	1 m	0.18	0.006	<0.05	0.4	-	0.024	0.005	9	10.2	16.5	6.8	117	15	90	40
		3 m	0.19	0.006	<0.05	0.5	-	0.022	0.005	9	8.9	15.0	6.4	115	13	<30	<30
	LR-4	1 m	0.19	0.005	<0.05	0.5	-	0.022	0.014	9	10.4	17.0	6.8	119	15	<30	<30
		3 m	0.19	0.005	<0.05	0.4	-	0.020	0.011	9	10.3	16.0	6.5	118	13	40	40
	LR-5	1 m	0.19	0.005	0.05	0.4	-	0.020	0.009	9	10.4	17.5	6.8	120	13	<30	<30
		3 m	0.19	0.005	0.05	0.4	-	0.025	0.009	9	10.2	16.0	6.8	116	14	<30	<30
	LR-6	Subsurface	0.48	0.21	0.52	0.8	-	0.032	0.015	19	2.8	16.5	5.8	141	25	2400	150
6-14-83	LR-1	1 m	0.02	0.006	<0.05	0.4	0.3	0.030	0.018	8	10.5	20.5	8.5	155	14	<30	<30
		15 m	0.12	0.009	0.62	0.9	0.9	0.030	0.011	11	0.4	7.5	4.9	142	19	-	-
	LR-2	1 m	0.02	0.006	<0.05	1.3	0.4	0.014	0.008	8	11.8	23.5	9.1	160	15	<30	<30
		3 m	0.02	0.006	<0.05	0.3	0.3	0.016	0.005	8	11.0	20.5	8.7	150	15	-	-
	LR-3	1 m	0.02	0.005	<0.05	0.4	0.4	0.020	0.016	10	12.0	23.5	8.9	150	15	<30	<30
		3 m	0.02	0.006	<0.05	0.4	0.3	0.020	0.007	8	11.0	20.5	8.9	160	15	-	-
	LR-4	1 m	0.03	0.006	<0.05	0.4	0.2	0.032	0.008	9	10.1	23.0	8.8	155	15	<30	<30
		3 m	0.02	0.006	<0.05	0.5	0.2	0.031	0.011	8	11.0	20.0	8.8	165	15	-	-
	LR-5	1 m	<0.02	0.006	0.07	0.7	0.5	0.026	0.010	8	11.0	23.5	8.7	150	15	<30	<30
		3 m	0.02	0.006	<0.05	0.6	0.6	0.030	0.010	7	10.8	20.5	8.7	160	15	-	-
	LR-6	Subsurface	0.28	0.024	0.64	1.1	1.1	0.041	0.030	20	1.4	20.0	5.5	175	28	930	<30
	Brkhvn B.	Subsurface	<0.02	0.006	<0.05	0.5	0.4	0.025	0.017	7	10.4	24.5	8.9	155	14	<30	<30
	Islip B.	Subsurface	<0.02	0.006	<0.05	0.6	0.5	0.022	0.011	8	10.8	23.0	8.5	155	15	<30	<30
6-28-83	LR-1	1 m	0.02	0.002	<0.05	0.5	0.2	0.026	0.007	12	10.0	25.0	9.35	140	20	230/4600	<30
		16 m	0.02	0.002	1.0	1.3	1.5	0.061	0.028	13	1.1	8.8	6.2	151	29	-	-
	LR-2	1 m	0.02	0.002	0.05	0.4	0.2	0.026	0.007	11	9.7	25.0	9.5	145	19	40	<30
		3 m	0.02	0.002	<0.05	0.4	0.4	0.028	0.008	12	8.7	24.0	6.9	141	18	-	-
	LR-3	1 m	<0.02	0.001	<0.05	0.5	0.2	0.026	0.005	11	9.7	25.0	9.5	144	16	90	<30
		3 m	<0.02	0.002	<0.05	0.8	0.3	0.028	0.006	11	7.8	24.0	9.1	144	17	-	-
	LR-4	1 m	<0.02	0.001	<0.05	0.5	0.4	0.023	0.002	11	9.4	25.0	9.5	148	16	40	<30
		3 m	<0.02	0.002	<0.05	0.6	0.4	0.024	0.007	11	9.4	25.0	9.5	148	16	-	-
	LR-5	1 m	<0.02	0.002	<0.05	0.5	0.4	0.024	0.009	11	9.5	25.0	9.5	145	17	<30	<30
		3 m	<0.02	0.002	<0.05	0.6	0.4	0.021	0.002	11	9.6	25.0	9.5	149	16	-	-
	LR-6	Subsurface	0.26	0.017	0.63	1.0	0.9	0.050	0.019	25	2.2	19.3	5.9	177	30	230/4600	<30
	Brkhvn B.	Subsurface	<0.02	0.002	0.05	0.6	0.3	0.021	0.004	11	9.7	25.0	9.6	150	17	230	40
	Islip B.	Subsurface	<0.02	0.002	<0.05	0.8	0.4	0.026	0.002	11	9.5	25.0	9.5	150	16	4600	<30

Appendix Table B-2.1 (Cont'd.)

DATE	STATION	DEPTH	*NO_3-N	NO_2-N	NH_3-N	TKN	DKN	TP	SP	TC	DO	TEMP (C°)	pH	COND. $\mu S/cm^2$	ALKALINITY mg/l $CaCO_3$	TOT COL. MPN/100 ml	FEC. COL. MPN/100 ml
7-19-83	LR-1	1 m	<0.02	0.001	<0.05	0.2	0.2	0.022	0.006	12	8.8	27.5	8.3	144	21	<30	<30
		15 m	< 0.02	0.003	0.96	1.0	0.7	0.044	0.027	12	<1.0	9.0	6.6	150	29	-	-
	LR-2	1 m	<0.02	0.002	<0.05	0.5	0.1	0.022	0.008	12	8.5	27.8	8.4	147	16	30	<30
	LR-3	1 m	<0.02	0.002	<0.05	0.5	0.4	0.022	0.003	12	8.6	27.8	8.3	147	17	<30	<30
	LR-4	1 m	<0.02	0.002	<0.05	0.3	0.2	0.023	0.009	12	8.8	27.3	8.3	146	18	<30	<30
	LR-5	1 m	<0.02	0.002	<0.05	0.5	0.5	0.021	0.010	12	8.8	27.3	8.2	146	17	<30	<30
	LR-6	Subsurface	0.12	0.009	0.56	0.8	0.6	0.049	0.015	22	1.4	20.0	6.4	180	31	230	40
	Bkvn B.	Subsurface	<0.02	0.001	<0.05	0.3	0.2	0.022	0.005	11	8.6	27.5	8.5	148	18	40	<30
	Islip B.	Subsurface	<0.02	0.001	0.05	0.2	0.1	0.023	0.008	11	8.9	27.0	8.7	146	18	40	<30
8-2-83	LR-1	1 m	<0.05	<0.002	0.07	1.3	0.8	0.030	0.020	15	9.8	26.0	9.3	150	19	70	<30
		15 m	<0.05	0.002	1.7	2.2	2.1	0.113	0.083	18	<1.0	8.5	6.9	146	39	<30	<30
	LR-2	1 m	<0.05	0.003	0.08	1.1	0.5	0.032	0.009	13	9.8	26.0	9.4	153	18	230	90
	LR-3	1 m	<0.05	0.002	0.05	1.2	0.7	0.018	0.012	14	9.8	26.0	9.5	153	18	40	40
	LR-4	1 m	<0.05	0.002	0.06	1.1	0.5	0.028	0.012	14	9.7	26.0	9.4	153	18	430	<30
	LR-5	1 m	<0.05	0.002	0.06	1.1	0.5	0.025	0.011	14	9.8	26.0	9.4	152	19	40	<30
	LR-6	Subsurface	0.13	0.011	0.60	1.0	1.0	0.048	0.022	25	1.1	20.0	6.2	172	29	4600	2400
	Bkvn B.	Subsurface	<0.05	0.002	0.07	1.6	0.5	0.032	0.014	15	10.2	26.0	9.4	152	19	230	90
	Islip B.	Subsurface	<0.05	0.003	0.08	1.2	0.6	0.029	0.011	14	10.8	26.5	9.4	152	19	150	40
8-16-83	LR-1	1 m	0.05	0.002	0.36	0.8	0.8	0.019	0.006	11	7.1	23.0	6.3	139	20	430	<30
		15 m	<0.05	0.001	1.3	1.6	1.4	0.068	0.043	15	1.5	8.5	6.4	148	38	-	-
	LR-2	1 m	<0.05	0.002	0.36	0.8	0.7	0.025	0.008	11	8.0	23.0	6.8	138	20	<30	<30
	LR-3	1 m	<0.05	0.002	0.36	1.3	1.2	0.018	0.010	11	8.2	23.0	6.7	136	20	<40	<30
	LR-4	1 m	<0.05	0.002	0.36	0.8	0.6	0.028	0.011	11	8.0	23.0	6.9	139	21	40	<30
	LR-5	1 m	<0.05	0.002	0.35	0.8	0.7	0.018	0.008	11	8.0	23.0	6.8	140	20	90	40
	LR-6	Subsurface	0.06	0.008	0.33	0.9	0.9	0.040	0.013	20	2.1	18.5	6.3	124	25	460	2400
	Bkvn B	Subsurface	<0.05	0.002	0.36	1.0	0.6	0.018	0.007	11	-	-	6.9	144	21	2400	2400
	Islip B.	Subsurface	<0.05	0.002	0.34	0.8	0.6	0.018	0.006	11	-	-	6.8	140	20	2400	2400
8-30-83	LR-1	1 m	<0.05	0.002	<0.05	0.6	0.2	0.028	0.015	12	8.9	25.3	8.0	143	22	<30	<30
		15 m	<0.05	0.002	1.2	1.2	1.0	0.059	0.044	14	0.2	9.0	6.35	151	34	150	30
	LR-2	1 m	<0.05	0.002	0.05	0.5	0.2	0.031	0.013	10	8.6	25.5	8.0	146	20	<30	<30
	LR-3	1 m	<0.05	0.002	<0.05	0.8	0.2	0.032	0.011	11	8.8	25.3	8.1	146	19	<30	<30
	LR-4	1 m	<0.05	0.002	0.08	0.7	0.3	0.028	0.012	10	8.8	25.3	8.2	146	19	<30	<30
	LR-5	1 m	<0.05	0.002	<0.05	0.5	0.2	0.029	0.012	10	8.8	25.3	8.2	145	20	30	<30
	LR-6	Subsurface	0.20	0.012	0.53	0.5	0.4	0.038	0.012	19	1.2	19.5	6.1	175	29	2100	230
	Bkvn B	Subsurface	<0.05	0.002	0.05	0.5	0.2	0.026	0.013	11	8.8	25.3	8.1	146	19	90	40
	Islip B	Subsurface	<0.05	0.002	0.05	0.5	0.2	0.027	0.011	12	8.7	25.3	8.2	146	19	40	<30

Appendix Table B-2.1 (Cont'd.)

DATE	STATION	DEPTH	*NO_3-N	NO_2-N	NH_3-N	TKN	DKN	TP	SP	TC	DO	TEMP (C)	pH	COND. µS/cm^2	ALKALINITY mg/l $CaCO_3$	TOT COL. MPN/100 ml	FEC. COL. MPN/100 ml
9-27-83	LR-1	1 m	<0.05	0.002	0.30	1.4	0.9	0.022	0.006	14	7.4	20.0	6.6	144	21		
		15 m	<0.05	0.004	1.9	2.7	2.1	0.105	0.085	18	1.2	9.0	6.4	149	44		
	LR-2	1 m	<0.05	0.002	0.33	1.3	0.9	0.034	0.013	10	7.5	20.0	6.3	140	22		
	LR-3	1 m	<0.05	0.003	0.34	1.4	1.3	0.030	0.012	13	7.4	20.0	6.4	142	21		
	LR-4	1 m	<0.05	0.002	0.31	1.5	1.1	0.023	0.011	14	6.8	20.5	6.3	142	21		
	LR-5	1 m	<0.05	0.003	0.33	1.4	1.0	0.32	0.015	13	6.9	20.5	6.3	142	21		
	LR-6	Subsurface	0.022	0.016	0.69	0.9	0.9	0.023	0.009	19	2.1	15.5	5.9	172	32		
11-1-83	LR-1	1 m	<0.05	0.003	0.61	0.8	0.6	0.034	0.010	12	10.0	11.0	6.5	135	20		
		15 m	<0.05	0.002	0.54	0.6	0.6	0.034	0.011	12	9.1	11.0	6.1	139	20		
	LR-2	1 m	<0.05	0.003	0.60	0.6	0.6	0.033	0.026	12	9.9	11.0	-	135	-		
	LR-3	1 m	<0.05	0.003	0.58	0.6	0.5	0.042	0.015	12	10.4	11.0	-	141	-		
	LR-4	1 m	<0.05	0.003	0.56	0.6	0.4	0.038	0.022	12	-	-	-	135	-		
	LR-5	1 m	<0.05	0.003	0.57	0.5	0.5	0.037	0.016	10	-	-	-	139	-		
	LR-6	Subsurface	0.46	0.016	0.88	0.8	0.8	0.040	0.027	24	6.5	9.5	6.0	166	28		
11-20-83	LR-3	1 m	0.07	0.006	0.46	0.2	0.2	0.028	0.010	10	12.6	9.0	6.6	-	14		
	LR-6	Subsurface	0.53	0.017	0.62	0.3	0.4	0.058	0.022	19	5.9	11.0	6.4	-	24		
12-20-83	LR-1	1 m	0.23	0.006	0.30	0.8	0.4	0.024	0.008	10	13.9	2.0	6.0	125	13		
		15 m	0.20	0.006	0.27	0.7	0.5	0.024	0.008	9	12.0	4.0	5.9	96	14		
	LR-2	1 m	0.19	0.006	0.30	0.8	0.5	0.031	0.011	10	12.9	3.0	-	114	-		
	LR-3	1 m	0.20	0.006	0.30	0.8	0.6	0.030	0.011	10	12.8	3.0	-	115	-		
	LR-4	1 m	0.18	0.005	0.26	0.6	0.5	0.026	0.0119	13.0	3.0	-	121	-			
	LR-5	1 m	0.18	0.005	0.29	0.7	0.6	0.024	0.011	9	12.9	3.0	-	125	-		
	LR-6	Subsurface	0.96	0.011	0.73	0.8	0.8	0.026	0.011	14	8.6	1.5	6.1	139	24		
3-20-84	LR-1	1 m	0.20	0.005	0.06	0.4	0.3	0.016	0.006	10	14.0	4.0	6.3	132	11		
		15 m	0.22	0.004	0.06	0.3	0.2	0.018	0.004	11	14.6	4.0	6.2	129	11		
	LR-2	1 m	0.20	0.005	0.05	0.4	0.2	0.015	0.005	9	13.8	4.0	6.1	130	11		
	LR-3	1 m	0.25	0.005	0.07	0.4	0.2	0.023	0.004	11	13.8	4.0	6.0	128	11		
	LR-4	1 m	0.24	0.005	0.07	0.3	0.2	0.017	0.005	10	14.2	4.0	6.2	133	12		
	LR-5	1 m	0.22	0.005	0.06	0.3	0.2	0.014	0.004	11	14.2	4.0	6.3	131	11		
	LR-6	Subsurface	1.3	0.009	0.19	0.3	0.3	0.012	0.002	11	11.8	6.0	5.5	150	13		

Appendix Table B-2.1 (Cont'd.)

DATE	STATION	DEPTH	*NO_3-N	NO_2-N	NH_3-N	TKN	DKN	TP	SP	TC	DO	TEMP (C)	pH	COND. $\mu S/cm^2$	ALKALINITY mg/l $CaCO_3$	TOT COL. MPN/100 ml	FEC. COL. MPN/100 ml
4-10-84	LR-1	1 m	0.33	0.005	0.10	0.3	0.3	0.013	0.007	10	12.0	8.0	6.9	160	12		
		15 m	0.25	0.004	0.09	0.1	0.2	0.021	0.007	11	12.4	8.0	6.7	137	13		
	LR-2	1 m	0.24	0.005	0.09	0.4	0.4	0.020	0.008	10	12.0	8.0	6.8	140	12		
	LR-3	1 m	0.22	0.004	0.08	0.7	0.4	0.019	0.008	10	12.1	8.0	6.9	139	12		
	LR-4	1 m	0.21	0.005	0.09	1.9	0.4	0.021	0.007	10	12.1	8.0	6.9	144	11		
	LR-5	1 m	0.20	0.004	0.08	0.5	0.4	0.021	0.007	9	12.0	8.0	6.7	144	12		
	LR-6	Subsurface	0.82	0.017	0.48	0.5	0.5	0.029	0.014	14	9.5	9.5	6.5	125	23		
5-7-84	LR-1	1 m	0.08	0.006	<0.05	0.7	0.4	0.023	0.009	8	12.0	15.5	6.6	154	8		
		15 m	0.08	0.005	0.12	0.5	0.4	0.022	0.007	8	7.0	11.0	6.3	153	10		
	LR-2	1 m	0.09	0.005	<0.05	0.3	0.3	0.031	0.004	8	12.0	15.5	6.6	151	9		
	LR-3	1 m	0.06	0.005	<0.05	0.3	0.3	0.023	0.006	7	12.0	15.5	6.6	154	9		
	LR-4	1 m	0.07	0.005	<0.05	0.5	0.3	0.028	0.014	9	12.2	15.5	6.6	150	9		
Sample Lost	LR-5	1 m															
	LR-6	Subsurface	0.18	0.027	0.68	1.1	1.1	0.023	0.014	18	4.5	14.5	6.2	135	19		

* All units mg/l unless specified

Appendix Table B-2.3
Duplicate and Replicate Chlorophyll a Sample Analyses

TYPE of SAMPLE	LOCATION of SAMPLE	SAMPLE NUMBER	CHOROPHYLL a CONCENTRATION µg/l
Duplicate	LR-1	1.1	41.1
		1-2	32.1
		% Difference	22%
	LR-6	2-1	31.6
		2-2	48.9
		% Difference	35%
	LR-6	3-1	6.2
		3-2	6.2
		% Difference	0%
	LR-1	4-1	15.0
		4-2	15.5
		% Difference	3%
Replicate	LR-1	1-1	9.6
		1-2	9.7
		% Difference	1%
	LR-6	2-1	9.6
		2-2	9.6
		% Difference	0%
	LR-1	3-1	31.8
		3-2	34.0
		% Difference	6%
	LR-6	4-1	45.7
		4-2	42.1
		% Difference	8%
	LR-1	5-1	34.5
		5-2	33.8
		% Difference	2%
	LR-5	6-1	32.7
		6-2	31.4
		% Difference	4%
	LR-1	7-1	15.6
		7-2	16.0
		% Difference	3%
	LR-2	8-1	15.9
		8-2	16.0
		% Difference	1%
	LR-3	9-1	13.5
		9-2	14.5
		9-3	13.9
		% Difference	7%
	LR-6	10-1	13.3
		10-2	11.8
		10-3	12.2
		% Difference	11%
	LR-1	11-1	18.8
		11-2	18.1
		% Difference	5%
	LR-1	12-1	6.6
		12-2	6.9
		% Difference	4%
	LR-3	13-1	7.2
		13-2	6.9
		% Difference	4%
	LR-1	14-1	9.3
		14.2	8.5
		%Difference	9%
	LR-4	15-1	10.6
		15-2	9.7
		% Difference	8%

Appendix C

The concept of Event Mean Concentration (EMC) was developed for the *Nationwide Urban Runoff Program* (NURP) to assess the pollution potential and impact of storm event related discharges. In the Lake Ronkonkoma Study it was used to assess the pollution carried by the stormwater runoff into the lake. By definition, the EMC is the total quantity (usually expressed in units of weight such as mg, pounds, etc.) of the pollutant of interest discharged during a runoff event, divided by the total runoff quantity (usually expressed in units of volume such as cubic feet, liters, etc.) discharged during the event.

The equation for the calculation of the EMC is as follows:

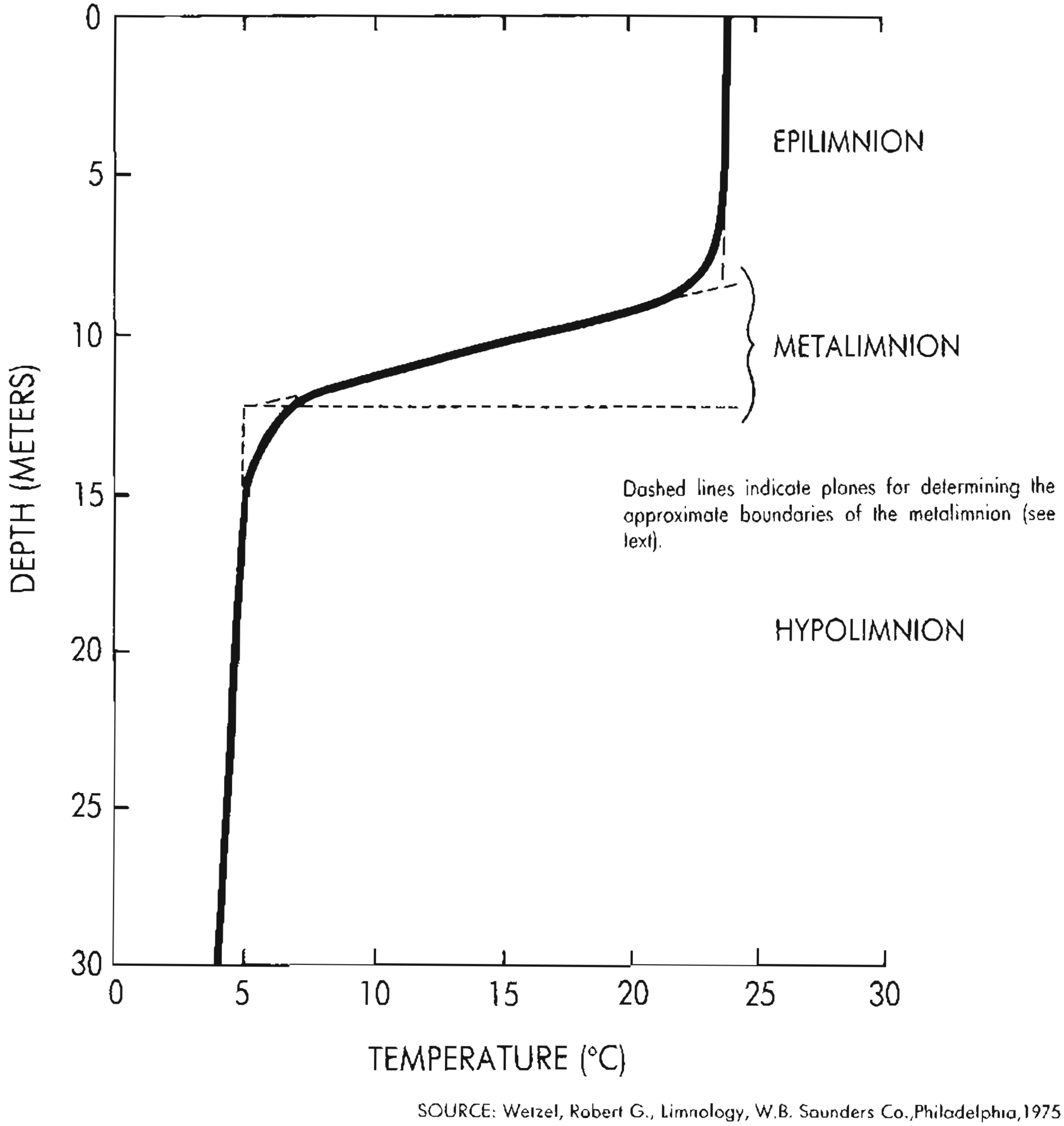
$$EMC = \frac{\Sigma(t_{n+1} - t_n)\ \frac{1}{2}\ (c_n q_n + c_{n+1}\ q_{n+1})}{\Sigma(t_{n+1} - t_n)\ \frac{1}{2}\ (q_n + q_{n+1})}$$

c_n = pollutant concentrations determined from each sample
q_n = instantaneous flow rate
t_n = time

This explanation and equation was provided by Philip E. Shelley, Ph.D. and was included in correspondence from the United States Environmental Protection Agency to the Suffolk County Department of Health Service dated Sept. 1981. A further discussion on EMC's was contained in a report by Dr. Heaney and Huber, *Urban Rainfall-Runoff-Quality Data Base,* published in EPA-600/8-79-004, August 1979.

Appendix D-Glossary

Allochthonous	Having been introduced from the outside of the lake by inflowing water.
Autochthonous	Having been formed in the lake itself by life processes or physical-chemical processes.
Biochemical Oxygen Demand (BOD)	The amount of oxygen required by the biological population of a water sample to oxidize the organic matter in that water. It is usually determined over a 5-day period under standardized laboratory conditions and hence may not represent actual field conditions.
Dimictic	A lake with two seasonal overturns (periods of free circulation), normally in spring and fall.
Epilimnion	The upper stratum or layer of a lake that occurs above the metalimnion (the thermocline). The epilmnion is characterized by more or less consistent temperature and continuous mixing. (See Appendix Figure D-1).
Hypolimnion	The relatively deep and undisturbed part of the lake below the thermocline. (See Appendix Figure D-1).
Overturn	Lakewide circulation generally occurs two times a year, in the fall and in the spring. As fall progresses, the upper layer of the lake (epilimnion) begins to cool off until the temperature of the epilimnion is the same as the hypolimnion. Since the thermocline no longer exists to prevent circulation between the upper and lower layers, the entire lake mixes from top to bottom. As the temperature continues to drop, the water at the top of the lake continues to lose heat. Since the water on top is less dense than in the lower layers, a reverse situation will occur. There will be a cold epilimnion overlying a warm hypolimnion. If the surface temperature drops below four degrees centigrade, ice forms and the wind driven epilimnion ceases. During spring, the temperature of the epilimnion increases, until the lake temperature is a uniform four degrees centrigrade and overturn occurs once again.
Polymictic	A lake that can overturn or mix thoroughly at any point in time.
Pulse Pollution	Runoff from a storm event or pollution from a pipe that is discharged periodically. The period or cycle is a result of the event that produces it, such as pumping from a recharge basin.
Thermocline (also called **metaliminion)**	The plane or surface layer in vertically stratified water where there is a rapid change in temperature from the overlying to the underlying waters. A thermocline exists wherever there is a 1°C or greater change in temperature per meter of depth.



Appendix Figure D-1 Typical thermal stratification of a lake into the epilimnetic, metalimnetic, and hypolimnetic water strata.

Appendix E - Nonpoint Source Management

Stormwater Management Plan

MUNICIPALITIES[1]

- Require a stormwater management plan for any property when
  - a plat is to be recorded
  - land is to be subdivided
  - an existing drainage system may require alteration
  - new development for any use other than single family residence is proposed
  - the rate or volume of runoff will be significantly increased
  - on-site water drains to a pond, stream or other surface water body or to a wetland

The stormwater management plan may be a part of a site plan or supportive specifications or other written material, and should indicate the manner in which the applicant will meet the required performance standards.

- The Plan should contain the following information:
  1. A description of the existing site conditions including
     - topography
     - location and description of surface waters, freshwater and tidal wetlands, existing woodland or other vegetation, soils, high water table areas, the depth to seasonal high water table, location of the 100 year flood plain.
     - existing structures, utilities
     - the direction, flow, rate, and volume of stormwater runoff under existing conditions (if partially developed or developed) or natural conditions (if not developed)
     - the areas on-site or off-site that currently receive stormwater runoff
  2. All proposed site changes including:
     - changes in topography
     - changes in land surfaces (i.e. show locations where vegetation is to be removed and lawns or paving installed)
     - proposed site construction and planting areas
     - locations of all buildings and structures
  3. The resultant changes in the volume and rate of stormwater runoff (based upon a given year storm to be determined by the municipality - suggest a 25 year storm) from various locations on the site
  4. The description of the proposed stormwater drainage system including:
     - the proposed location of stormwater control measures
     - the designed volume, rate, flow path, detention and retention of stormwater on-site
     - the amount and rate of off-site stormwater discharged from the site
     - the location and description of erosion and sedimentation control measures
     - the description of the pollutants likely to be generated on-site
     - the potential impact upon groundwater, and surface waters

- Incorporate the following erosion and sedimentation controls into local ordinances. The design, construction and maintenance of erosion control systems should be consistent with the following proposed local controls:
  - A ban on the commencement of grading, cutting or filling until erosion and sedimentation control devices have been installed between the disturbed area and waterbodies, watercourses and wetlands.

[1] Long Island Regional Planning Board 1983, Nonpoint Source Management Handbook.

- A requirement that land which has been cleared for development and upon which construction has not commenced shall be protected from erosion by appropriate techniques designed to revegetate the area.

- A ban on the use of wetlands and other waterbodies as sediment traps.
- Provision of regular maintenance to insure that erosion and sedimentation facilities continue to function properly.
- A requirement that artificial watercourses should be designed, so that the velocity of flow will not cause erosion.
- The creation of vegetated buffer strips where practicable, and the retention of existing growth along the banks of all watercourses, waterbodies or wetlands. The width of the buffer should be sufficient to prevent erosion, trap the sediment in overland runoff, provide access to the waterbody and allow for periodic flooding without damage to structures.
- The use of retention and detention ponds to retain and detain the increased runoff and sediments that the development generates. Water should be released from detention ponds into watercourses or wetlands at a rate and in a manner approximating the natural flow that would have occurred before development. The banks of detention and retention areas shall slope at a gentle grade into the water as a safeguard against drowning, personal injury or other accidents, and also to encourage the growth of vegetation and to allow the alternate flooding and exposure of areas along the shore as water levels periodically rise and fall.

(The erosion controls listed above were among a number suggested in an article entitled Stormwater Runoff Control: A Model Ordinance For Meeting Local Water Quality Management Needs by Maloney, et. al. - which appeared in the Natural Resources Journal, Vol. 20, October 1980.)

- Require an erosion control plan whenever a stormwater management plan is required.
- Withold the certificate of occupancy until the stormwater control measures and erosion and sedimentation control measures are installed in accordance with this plan.

Site Planning Recommendations

SITE ANALYSIS

Success in the reduction of stormwater related impacts and the costs of installing stormwater systems depends in large measure, on proper site analysis and the selection and placement of development suited to the site.

- Undertake a careful site analysis to identify any developmental constraints affecting the design of a stormwater control system that may be imposed by the location of existing on-site and off-site features. The site analysis process should include the following steps:
  - Prepare a key map locating the site within the watershed or drainage basin
  - Prepare a watershed analysis map showing the site drainage system in relation to the watershed. Locate all natural drainage swales, depressions, slopes, high points, low points, flood prone areas, areas with depth to seasonal high water table less than three feet, areas of existing vegetation, sensitive wildlife habitats, and soil constraints. Stormwater impacts can be minimized by avoiding soil conditions with severe or moderate constraints.
    - a *slight constraint* indicates no limitations or a few that can be overcome with relatively little cost.
    - a *moderate constraint* indicates that the limitations are more difficult and expensive to correct.
    - a *severe constraint* indicates the soil is very poor and will require replacement filling or modification if used. Filling is not recommended.
- Locate on-site areas suitable for the recharge of stormwater

- Locate on-site areas suitable for development. Site building and paved areas only when the presence of the environmental conditions are favorable. The following soil and slope conditions may indicate soil suitability for development:
  - nearly level or moderately sloped terrain; (less than eight percent slope)
  - moderately to rapidly drained soils; (a moderate to high permeability rate)
  - a coarse or medium textured soil
  - a *seasonal high water* table more than five feet below the surface.
  - other soils listed under *slight constraints* in Appendix Table E-1
- Consult the County Health Departments for information concerning the movement of groundwater and recorded fluctuations in the water table elevations

SITE PLANNING

Use proper site design as described in the Site Plan Review Chapter[1], other chapters and the following:

- Minimize grade changes and site clearing
- Retain native vegetation on steep slopes, in swales, on Carver or other excessively drained sandy-gravelly soils, on soils with a high content of silts, fine sands and clays, and in areas with a high water table or adjacent to surface waters
- Avoid the use of paved surfaces such as parking lots and roadways where the presence of the following conditions indicate potential problems:
  - severely sloped terrain
  - flood plain areas
  - existing swales
  - lowland areas
  - depressions, kettleholes
  - soil constraints listed as *severe or moderate* in Appendix Table E-1

Appendix Table E-1
Limitations of Soils for Areas in the Lake Ronkonkoma Watershed Area Where Additional Stormwater Runoff Will be Generated or Recharged

SEVERE CONSTRAINTS	MODERATE CONSTRAINTS	SLIGHT CONSTRAINTS[2]
Beaches	Carver & Plymouth sands, 8-15% slopes	Plymouth loamy sand, 0-8% slopes
Carver & Plymouth sands 15-35% slopes	Cut & fill land, gently sloping	Carver & Plymouth sands 0-8% slopes
Muck	Haven loam, 6-12% slopes	Haven loam, 0-6% slopes
	Plymouth loamy sand, 8-15% slopes	Made land
	Riverhead sandy loam, 8-15% slopes	
	Riverhead & Haven soils, 8-15% slopes	

[1]Nonpoint Source Management Handbook, LIRPB, 1983.
[2]There also may be moderate constraints for recharge of stormwater for these soils in this category. All soils should be checked for permeability rates.

Source: Soil Survey of Suffolk County. United States Department of Agriculture Soil Conservation Service and the Cornell Agricultural Experiment Station, April 1975.

- Incorporate the following general stormwater controls checklist into the site design as needed to meet the performance standards listed:
  - Reduce the extent of impermeable surfaces insofar as possible
  - Use man-made swales and shallow depressions to collect stormwater on-site, wherever possible
  - Preserve existing swales in their natural state. Avoid disturbance of existing grades, vegetation (particularly ground cover) or soils and the alteration of surface hydrology
  - Provide temporary on-site areas to receive stormwater runoff flows that are generated by construction and other site development activities
  - Do not allow increased sediment resulting from the construction or operational phase of site development to leave the site or to be discharged into stream corridors, marine or freshwater wetlands.
  - Minimize the amount of soil area exposed to rainfall and the period of exposure. Cover or plant exposed soils as soon as possible.
  - Do not allow the dumping or filling of excess soil or other materials generated from site development into swales and surface waters
  - Detain runoff on-site and direct stormwater from road surfaces to sediment basins before discharge to a sump wherever topography limits or precludes the on-site recharge. At sites where vertical drainage is not feasible, all runoff from a 25 year frequency, 24-hour storm from unstabilized soil areas should be collected, desilted, and released into stable channels at an acceptable design velocity appropriate for channel characteristics.

Once the site plan has been partially completed, undertake the following steps:

- Calculate the amount of stormwater entering the site
- Calculate the amount of natural runoff from the site
- Calculate the additional amount of runoff due to the proposed installation of impermeable paving and other surfaces
- Locate areas on-site for the storage and recharge of stormwater
- Reevaluate the site plan if the storage and recharge area capacity is not sufficient

STORMWATER CONTROL MEASURES FOR SITE DEVELOPMENT

- Minimize on-site runoff and erosion by using the control measures listed in Appendix Table E-2.

COMBINE DEVELOPMENT AND STORMWATER CONTROLS

- Use cluster development as a viable alternative to conventional subdivision layout to preserve environmentally sensitive qualities of wetlands, aquifer recharge areas, swales and woodlands.
- Reduce the length of roadways, thereby reducing the extent of cut and fill areas and stormwater runoff volumes and minimizing the possibility of sedimentation/erosion.
- Reduce the area of other impermeable surfaces such as walkways, patios and recreational facilities.
- Allocate open space for recreation and aquifer recharge.

NATURAL VEGETATION

- Use natural vegetation as an important nonstructural alternative in the control of stormwater runoff and erosion/sedimentation. Natural vegetation includes woodlands, free standing trees, old fields, grasses, and wetlands. When left undisturbed, vegetation stabilizes steep slopes, streambanks, and drainageways by
  - reducing stormwater velocity, allowing for absorption of water to occur, thus recharging the aquifer below.
  - acting as a filter by trapping sediment particles.
  - holding soil particles in place.

Appendix Table E-2
Structural and Nonstructural Stormwater Control Measures

MEASURE	STRUCTURAL	NON-STRUCTURAL	PURPOSE	RECOMMENDATION FOR USE
Permeable Paving	X		Reduce the volume and rate of stormwater runoff; allow for increased infiltration.	Patios and walkways; use on slopes less than five percent where soils have a moderate to high rate of permeability; adequate depth to seasonal high water table.
In-Line Storage	X		Collect stormwater runoff from parking lots and roadways; allow for percolation of runoff.	In areas where there is adequate depth between the bottom of leaching pools and leaching catch basins and the seasonal high water table.
Perforated reinforced concrete pipe	X		Allow for recharge of stormwater	General use
Natural Depressions		X	Collect and detain runoff; slow stormwater velocity to allow for recharge; protect low-lying areas and downstream development from flooding.	Upland areas in or adjacent to drainage areas by streams or waterways.
Gutters and Downspouts	X		Collect and convey runoff from roofs to leaching pools or other stable outlet.	For residential and commercial structures where roof top storage is not feasible; any site development, especially dense development where large volumes of roof runoff are anticipated.
Natural Vegetation		X	Control runoff and erosion/sedimentation; slow stormwater velocity to allow for increased infiltration; trap sediment particles; roots hold soil particles in place.	Upland areas, slopes, land area adjacent to surface waters and bluffs, streambanks, drainageways.
Wetlands		X	Buffer and stabilize lowland areas; slow runoff velocity and retain runoff, filter and trap suspended debris.	Along rivers, streams, and other surface water systems.
Sediment Ponds/ Basins	X		Protect surface waters from increased sediment loads; reduce the potential of flooding for downstream lands.	Construction sites; areas of highly erodible soils and sloped terrain.
Energy Dissipation	X		Slow stormwater velocity to a non-erosive level; trap debris, permit the settling of suspended solids and accompanying contaminants.	Adjacent to culverts, outlets, and drainage channels, and along streambanks; to prevent erosion and/or scouring.
Sediment Filter	X		Trap suspended particles and debris from stormwater runoff.	Adjacent to culverts, outlets, and drainage channels, and along streambanks; to prevent erosion and/or scouring.
Stormwater Retention (Ponds/basins)	X		Retain sediments (and runoff) to allow for the die-off of bacteria; reduce peak runoff flows and protect downstream properties from flooding; protect streams from increased sediment loadings.	To receive stormwater from drainage channels in areas where recreational and water amenities are desired; (permanent pond) and in areas where heavy sediment loads are not anticipated.
Stormwater Detention (Ponds/basins)	X		Temporarily detain runoff with gradual release to surface or groundwaters; reduce peak runoff flows; protect downstream development from flood potential	Upland sites and other sites where there is sufficient distance to seasonal high water table, drainage areas adjacent to streams and waterways; can function as a recreation area when properly vegetated and designed to drain completely.
Surface Drainageway	X	X	Direct runoff from areas where it could cause flooding, erosion and/or sedimentation.	Along slopes where soils are exposed during construction; newly constructed fill slopes; and in areas of highly erodible soils.
Grass or Vegetated Waterway		X	Convey runoff to a stable outlet; grasses can reduce energy of flow, permitting infiltration.	Areas where slopes are moderate and runoff velocities are non-erosive; areas where increased stormwater volumes will not exceed the capacity of the channel.
Bare Channel		X	Convey and/or direct runoff on construction sites.	Areas where the slope gradient is minimal and the runoff velocity is low; avoid use in areas with highly erodible soils.
Structurally-lined Channel (riprap, asphalt, concrete)	X		Convey and/or direct runoff; channel outlet must be well-stabilized, there is little or no energy dissipation along an impervious-lined channel.	Drainage areas having a high slope gradient or where runoff velocities are erosive, prohibiting the establishment of vegetation.
Man made Drainage Swales		X	Convey and/or recharge stormwater runoff.	Recommended for most sites where control of low volume stormwater flow is required.
Biofiltration Systems	X		Minimize pollutant loadings carried in stormwater runoff to surface waters; aquatic plants absorb contaminants (coliform, metals, nutrients) and trap suspended solids.	Where there is adequate area to construct such a pond; drainage areas that empty into surface waters; where construction of a recharge area is not feasible due to the shallow depth of the water table.
Soil/Slope Stabilization	X	X	Protect exposed soils from runoff impacts, erosion and sedimentation (see Table 5); reduce runoff velocities allowing for infiltration; hold vegetation in place until roots are established.	Slopes and other areas where soils are exposed during construction, newly constructed fill slopes; soil stockpile areas.

- Identify site locations where existing vegetation will not be disturbed by grading, filling or removal. Removal exposes valuable topsoil, making it highly susceptible to erosion/sedimentation.
- Do not store top soil on the vegetation.
- Stabilize exposed slopes during and after construction, by using temporary and/or permanent, structural or nonstructural stabilization measures. All areas not to be covered with an impervious surface should be temporarily stabilized immediately following disturbance. Permanent stabilization measures should be installed as soon as possible.

NATURAL DEPRESSIONS

- Use natural depressions to collect runoff from the surrounding development and slow its velocity, allowing for recharge. Natural depressions consist of gently sloping land, vegetated with grasses, understory vegetation, and/or trees. Depressions also function as holding areas of runoff, allowing sediment particles and debris to settle out before discharge to nearby surface waters. Except during storm events, depressions may also serve as recreational open space. They are visually pleasing and may be preferable to recharge basins, where the depressions can provide sufficient retention capacity.

WETLANDS

- Do not discharge stormwater directly into freshwater or tidal wetlands.

STORMWATER DETENTION

- Use stormwater detention (temporary detainment of stormwater runoff, with gradual release to surface or groundwaters) to maintain the same volume and rate of site runoff after development as that which existed prior to the development. Detention areas are designed to drain completely after a storm. An emergency spillway should be provided to allow release of runoff during storms that exceed the design capacity of the retention area. Except during storm events, detention areas may also serve as recreational open space and should be visually pleasing.
- Provide for maintenance of the control facility to insure sustained flow rates and its visual attractiveness. Prevent standing water which could be a hazard, and remove debris.

Maintenance of Septic Systems

Avoid Additives

Septic tanks do not require additives for effective operation. Various products (enzymes, etc.) marketed for that purpose do not improve the performance of the septic tank nor do they reduce the need for routine maintenance.

Minimize Discharge of Chemicals

Care should be taken to minimize discharges of chemicals into the tank. A slug of a toxic chemical that kills anaerobic bacteria can cause partial or complete loss of treatment for up to three weeks.

Do Not Discharge Grease into the Septic System

Pump Out the Tank as Needed

The septic tank should be pumped every two or three years to prevent clogging of the leaching pool and leaching field.

Keep the Leaching System in Good Repair

Leaching field repairs are needed once the infiltrative surface of the leaching pool and or the leaching field becomes clogged. Acids used to unclog the leaching field are of dubious value, present a safety problem and at best, offer only a temporary solution. Usually a more permanent repair such as providing an alternative leaching area is needed. This procedure is also necessary in many cases because the original design of the leaching area was too small. The old leaching area may be ready for reuse once it has been allowed to recover its infiltration capacity through natural oxidation of the soil clogging materials. Where the volume of the leaching field is limited, the system owner should devise a time schedule for the use of the alternative leaching pools.

Lawn Installation

Do not install lawns on soils listed in Appendix Table E-3 as soils having severe or moderate constraints

Appendix Table E-3
Limitations of Soils for Lawns

SEVERE CONSTRAINTS	MODERATE CONSTRAINTS	SLIGHT CONSTRAINTS
Atision sand	Bridgehampton silt loam, till substratum 6-12% slopes	Bridgehampton silt loam 0-6% slopes
Beaches	Haven loam 6-12% slopes	Bridgehampton silt loam, till substratum 2-6% slopes
Mucky sand	Montauk fine sandy loam 8-15% slopes	
Carver & Plymouth sands 0-35% slopes	Montauk silt loam 8-15% slopes	Haven loam 0-6% slopes
Cut & fill land	Raynham loam	Made land
Deerfield sand	Riverhead sandy loam 8-15% slopes	Montauk fine sandy loam 0-8% slopes
Dune land	Riverhead & Haven Soils 8-15% slopes	Montauk silt loam 0-8% slopes
Landfill (dredged, sandy)	Wallington silt loam	Montauk soils graded 0-8% slopes
Gravel pits 0-35% slopes	Walpole sandy loam	Riverhead sandy loam 0-8% slopes
Montauk loamy sands 0-35% slopes		Riverhead and Haven 0-8% slopes
Muck		Scio silt till substratum 2-6% slpoes
Plymouth loamy sandy 0-15% slopes		Scio silt loam, sandy substratum 0-6% slopes
Plymouth gravelly loamy sand 3-15% slopes		
Plymouth loamy sand silt substratum 0-8% slopes		
Riverhead very stony sandy loam 3-15% slopes		
Riverhead & Plymouth very bouldery soils 15-35% slopes		
Tidal Marsh		
Wareham loamy sand		
Whitman sandy loam		

Source: Soil Survey of Suffolk County, United States Department of Agriculture Soil Conservation Service and the Cornell Agriculture Experiment Station, April 1975.

Lawn Care to Minimize the Use of Fertilizers

APPLICATION of FERTILIZERS

Estimate Size of Area to be Fertilized

Select a Proper Fertilizer

Use a cyclone type spreader.

Calibrate the Spreader

Calibrate the spreader so that fertilizer is released at the appropriate speed. Select a 500 square foot area (10' x 50' or 20' x 25') for a test area. Determine the amount in pounds of fertilizer required to apply the nutrients at the rate of 1/2 pound per 1,000 square feet. Weigh the amount of fertilizer recommended (on the bag) for 1,000 square feet. Pour it into the hopper. Set the dial at the recommended setting. Go over the 500 square feet area with the spreader. If the setting is correct, 1/2 of the fertilizer should still be in the spreader. If more or less is present readjust the dial setting.

See Appendix Table E- 5 for fertilizer application guidelines for spring and fall for Kentucky bluegrass and perennial rye Grass. Fertilize fescues in the fall at the rate of 1/2 pound per 1,000 square feet and in the spring (at the same rate) only as needed.

Appendix Table E-5
Spring Application Guidelines

WEIGHT of BAG POUNDS	FERTILIZER FORMULATION (N-P-K)	SOIL CONDITION	RATE of APPLICATION	AREA of LAWN (Sq. Ft.)	No. of BAGS REQUIRED
50	20-10-5	pH of 6-7	1/2 lb./ 1000 ft.^{2}	2,000	1/10 bag
				5,000	1/4 bag
				10,000	1/2 bag
				20,000	1/4 bag
				40,000	2 bags
25	20-10-5	pH of 6-7	1/2 lb./ 1000 ft.^{2}	2,000	1/5 bag
				5,000	1/2 bag
				10,000	1 bag
				20,000	2 bags
				40,000	4 bags

Fall Application Guidelines

WEIGHT of BAG POUNDS	FERTILIZER FORMULATION (N-P-K)	SOIL CONDITION	RATE of APPLICATION	AREA of LAWN (Sq. Ft.)	No. of BAGS REQUIRED
25	16-4-8*	pH of 6-7	1/2 lb./ 1000 ft.	2,000	1/4 bag
				5,000	2/3 bag
				10,000	1.25 bag
				20,000	1.5 bags
				40,000	5 bags

*Typical ratio for a fall-winter application

Watering

Use low maintenance grasses or ground covers, such as fine fescues or wild flower sod, that do not require irrigation. Irrigation is not necessary for all home lawns. Fine fescue grasses do not need watering except during extremely droughty summers. Even then, care is needed to make sure that they are not overwatered. These fine fescues may turn yellow and then brown from lack of water in the summer, but will turn green again in the fall, since they are cool season grasses.

Irrigate bluegrass and perennial rye grass varieties during dry weather. Apply a minimum of 1/2" to 1" per application once a week or more as needed, depending on weather conditions, to encourage deep root growth. Whenever possible, water in the early to midmorning.

Grass Cutting

Remove no more than 1/3 of the grass blade each time the lawn is mowed. The grass should be kept as high as possible, a minimum of two inches, in order to maximize the root growth depth. The grass clippings should be left on the lawn as long as they do not suffocate the turf.

Timing of Fertilizer Application

Schedule fertilizer applications to coincide with turf needs. Fertilize cool season turf such as perennial rye grass and bluegrass in the spring and late fall and warm season grasses, such as zoysia, in the spring and summer. Since turf grass uptake of nitrogen is relatively steady throughout its growing season, small applications of nitrogen several times during the growing season may be preferable to one or two larger applications. Avoid fertilizing during a drought, when grass is essentially dormant and will not take up nutrients. Fertilize when the soil is moist. To avoid loss of fertilizer and leaching, do not apply fertilizer if there is likelihood of immediate heavy precipitation.

Submit Samples for Soil Test

Test soil prior to fertilizer application in order to determine liming and nutrient requirements for both turf and agricultural crops. Since fertilizer is used to add nutrients inadequately supplied by the soil, tests to determine existing pH and nutrient requirements are critical to assure efficient uptake, lowest cost and minimal groundwater impact.

Soil testing services are available through both the Nassau and Suffolk County Cooperative Extension Associations. Soil samples should be taken four to six weeks before seeding turf or fertilizing existing turf to allow sufficient time for the receipt of test results prior to the time for fertilizer application. Soil samples should be free of stones and thatch. A minimum of three samples should be taken from different areas. The samples should then be mixed and the composite should be submitted for soil analysis. Soil pH, nitrogen, phosphorus and potassium levels should be determined. Soil test kits, which can be used to analyze the nitrogen, phosphorus, potassium and pH of the soil, are also available for a nominal fee at retail establishments selling agricultural and landscaping supplies.

Apply Lime as Needed

Adjust the soil pH to 6.0 to 7.0. The lime (calcium carbonate-CaCo3) should be added to the soil approximately four weeks before the fertilizer is applied. If the existing pH is 5.0, then 50 to 100 pounds of 100 percent CaCo3 per 1000 square feet should be added and then mixed into the upper 4" to 6" of the soil. If the lime mixture is less than 100 percent CaCo3, then the application rate should be increased accordingly.

Fertilizer Selection

Utilize a slow release type of fertilizer such as isobutylidene diurea (IBDU), urea formaldehyde (UF), methylene urea, or sulfur coated urea (SCU) in order to minimize leaching.

This type of fertilizer allows for the controlled release of nitrogen to the soil over a longer period of time, thus facilitating increased absorption. Sometimes the application of inorganic fertilizers in either dry or liquid form applied at the rate of 1/2 pound per 1,000 square feet may be an appropriate alternative. Review Appendix Table 4 for the advantages and disadvantages of the use of various types of fertilizers.

Rate of Fertilization

Apply a maximum of one to two pounds of nitrogen per 1,000 sq. ft. per year. Since several applications are recommended throughout the growing season, use approximately 1/2 pound of nitrogen per 1,000 sq. ft. per application. Do not apply unless the turf appears to need it. See Appendix Table 5.

Appendix Table E-4
Description of Fertilizers

TYPE	NUTRIENT CONTENT	PROBLEMS	------PROPERTIES------			RECOMMENDED APPLICATION RATE	OTHER COMMENTS
Natural Organic Fertilizers:			Nutrient Availability	Solubility (Potential for Leaching to Groundwater)	Burn Potential		
Aged Animal Manure Bone Meal Decayed Plant Material Activated Sewage Sludge Other By-Products	The macronutrient content of organic fertilizers is usually very low. Natural organic fertilizers may contain micro nutrients.	Activated sewage sludge could contain heavy metals. Not as efficient as other fertilizers. Decayed plant material used on lawns may cause lawn disease.	Slow release. Low nitrogen content.	Low. Insoluble until decomposition occurs.	Usually low. If applied during hot weather nitrogen may be released too quickly.	As per package instructions.	Used to improve soil and for special plant uses.
Synthetic Organic Fertilizers:							
Ureaformaldehyde (UF) Methylol Urea[1] Methylene Urea Sulfur-coated Urea (SCU) Isobutylidene Diruea (IBDU)	These fertilizers may be low in potash and phosphorus.	More expensive. Fertilizer includes combination of small and larger particles. The smaller particles are more soluble. Breakdown of the larger particles is dependent upon soil bacteria that are usually more active during warmer weather This may result in lush growth that is susceptible to the disease organisms that are also increasing during warmer weather.	Generally slow release. About one-third of the nitrogen is quickly released (during the first week or two after application). The second one-third is released during the next week. The remainder is released over a period as long as six months.	Generally lower solubility.	Low to moderate.	Apply spring and fall at the rate of ½ to 1 lb. per 1,000 sq. ft.	More expensive. Considered better for lawns. Some of the nitrogen may be volatized or mechanically lost.

Appendix Table E-4 (Cont'd.)

TYPE	NUTRIENT CONTENT	PROBLEMS	------PROPERTIES------			RECOMMENDED APPLICATION RATE	OTHER COMMENTS
Inorganic Fertilizers:			Nutrient Availability	Solubility (Potential for Leaching to Groundwater)	Burn Potential		
Ammonium Sulphate Ammonium Nitrate Ammonium Phosphate Potassium Chloride (Muriate of potash) Urea[2]	Contain soluble salts of nitrogen and potassium and a complex of phosphorus compounds known as superphosphate. Usually blended with a carrier that prevents caking and allows for storage and use. The supplementary elements are not listed in the fertilizer analysis.	Most of the nitrogen applied in this class of fertilizers is available within two weeks. See solubility and burn potential. Do not apply when grass is damp unless lawn will be watered immediately after the fertilizer is applied. Do not apply during hot weather.	Fast release. Readily available.	High	Moderate to high. If too much fertilizer is applied, then leaf burn may occur (over two pounds per 1,000 sq. ft.). If the burn is severe enough, new growth must replace burned growth.	Apply spring and early fall at the rate of ½ lb. per 1,000 sq. ft. In the late fall apply fertilizers high in phosphorus at the rate of ½ lb. per 1,000 sq. ft.	Water after fertilization. Avoid heavy applications.

Notes:

Fescue and perennial rye grasses require less fertilizer than blue grass.
Lawns located in shade or partial shade require less fertilizer.
Turf needs more nitrogen and potash than phosphorus. Combinations such as 10-6-4, 10-5-10, 24-6-12, 18-4-9, 20-5-10 are recommended.
In the fall, the phosphorus percentage (middle number) should be increased.
Phosphorus applied in the upper soil layer before a lawn is planted provides for a denser stand of lawn.
Do not fertilize when seeding a lawn. This should occur at least two weeks before seeding. Liquid fertilizers that include ammonium may inhibit or prevent seed germination.
Liquid fertilization of lawn in the spring (when soils have dryed somewhat) may be the best method.

[1]Moderate release
[2]Considered an inorganic fertilizer in terms of solubility

Appendix F

Trophic Status

Lakes are characterized as oligotrophic or eutrophic on the basis of their trophic status. The term *trophic status* refers to the well-established ranking of lakes on a scale which expresses the productivity in terms of algae and fish, or the standing stock of algae and fish, or the input of nutrients from natural or man-made sources. More specifically, the term *oligotrophic* relates to the relative lack of nutrients and of organic production, whereas the term *eutrophic* designates a nutrient-rich condition or high standing stock. Other criteria can be used as well in differentiating these two lake types: phytoplankton and other species associations (Hutchinson 1967) and the presence and absence of oxygen in the deep (hypolimnetic) waters have been used (Thienemann 1928: see also Zafar 1959, for a review on this subject).

From a practical point of view, trophic status is related to several readily ascertainable characteristics of a lake. Oligotrophic waters are clear and therefore aesthetically pleasing but produce a relatively small crop of fish. By contrast, eutrophic waters are turbid and fertile. Eutrophic lakes also produce substantial growths of attached algae and other aquatic plants, often to the point of causing nuisance conditions and diminishing the recreational value of the lake.

Modern research has established the various relationships between the causes and the effects of nutrient inputs in quantitative terms. By the comparison of pristine lakes and watersheds and those affected by man's activities, it is possible to determine the trophic status of a lake and how that differs from the pristine condition of the lake (i.e., the condition of the lake with its watershed undisturbed by man). Determination of the trophic status of the lake, besides being of theoretical interest, has an eminently practical purpose, i.e., to determine how land use and pollution control practices affect present water quality and how changes in these practices can improve or endanger beneficial uses. The decision on the most desirable use of a lake is often difficult as it is dependent on the availability of alternatives, and local preferences.

Based on water column total phosphorus concentrations and chlorophyll **a** concentrations, Lake Ronkonkoma is eutrophic.To facilitate comparison, the pertinent data that characterize the trophic state of Lake Ronkonkoma and the boundary values of lake trophic status are listed in Table F-1.

Appendix Table F-1
Comparison of Lake Ronkonkoma Trophic Status Boundary Values

	--Chlorophyll a Concentration--			--Total Phosphorus Concentration--		
	Summer Mean	Peak	Annual Mean	Summer Mean	Spring	Annual Mean
Lake Ronkonkoma 1983	38.8 µg/l	89.4 µg/l	26.4 µg/l	25.3 µg/l	25.8 µg/l	25.4 µg/l
Eutrophic Border (Vollenweider Kerekes, 1980)	10-15 µg/l	≥25 µg/l	≥10 µg/l	≥25 µg/l	≥25 µg/l	≥25 µg/l

The chlorophyll **a** concentrations in Lake Ronkonkoma were well above the values that border the lower end of the eutrophic range. However, total phosphorus concentrations (TP) were just at the lower end of the eutrophic range. In fact, chlorophyll **a** concentrations were 4 to 7 times greater than expected, based on TP concentration (Dillon and Rigler, 1974; Jones and Bachmann, 1976; Vollenweider, 1976). The expected chlorophyll **a** concentrations and total phosphorus concentrations, based on three empirical models for north temperate lakes, are shown in Table F-2.

Appendix Table F-2
Lake Ronkonkoma Values Compared With North Temperate Lakes

Source	--Lake Ronkonkoma 1983-- Mean Summer Chl a	T.Phos.	--Predicted-- (for North Temperate Lakes) Mean Summer Chl a	T.Phos.
1 Dillon Rigler 1974 $Log_{10}Chl\ a = 1.449\ Log_{10}[Psp] - 1.136$	38.86 μg/l	25.8 μg/l*	8.11 μg/l	76.03 μg/l
2. Jones Bachmann 1976 $Log_{10}Chl\ a = 1.46\ Log_{10}[TP_{sum}] - 1.09$	38.86 μg/l	25.3 μg/l**	9.09 μg/l	68.43 μg/l
3. Vollenweider 1976 $Log_{10}Chl\ a = 0.91\ Log_{10}[P_x] - 0.435$	38.86 μg/l	25.4 μg/l***	6.97 μg/l	167.9 μg/l

*Spring TP
**Mean Summer TP
***Mean Annual TP

Lake Ronkonkoma produces a greater algal biomass per unit TP than most other north temperate lakes. The amount of algal biomass produced per unit TP is an important aspect of the lake ecosystem and directly affects lake management. Management decisions concerned with changing the algal production, and thereby the trophic status, rely heavily on the prediction of algal response to manipulation of the phosphorus influx. Therefore the relationship between mean summer chlorophyll **a** concentration and mean TP (chl **a**/TP) will be examined closely herein.

The chl **a**/TP can depend on factors that influence the proportion of algal-available phosphorus (dissolved phosphorus) in the TP concentration, and the chlorophyll **a** content of algal cells. There are four features of the Lake Ronkonkoma ecosystem which can contribute to the exceptionally high chl **a**/TP observed in this study. First, the dissolved phosphorus may continually comprise a greater proportion of TP than in most other north temperate lakes. Second, recycling of nutrients may be relatively rapid within the epilimnion due to the composition and abundance of the zooplankton community. Third, the chlorophyll **a** content per cell may have been routinely high reflecting multiple successive phytoplankton blooms. Fourth, cellular chlorophyll **a** concentrations may have been elevated in response to periods of exposure to low light intensities.

The dissolved phosphorus component of the TP may have been replenished throughout the growing season from within the lake. The depth of vertical mixing plays an important role in this respect. Continual resupply of dissolved phosphorus to the epilmnion can occur under aerobic conditions if the pH of the water is sufficiently elevated (i.e., ≥8.0) (Jacoby, et al. 1982), as occurred in Lake Ronkonkoma during June, 1983. Vertical mixing to the bottom not only assured that the elevated pH through photosynthesis generated in the trophogenic zone contacted the bottom, but also accounted for rapid distribution of the sediment-released phosphorus to the trophogenic zone. Periodic release of dissolved phosphorus from the sediments can also occur under anaerobic conditions. An anaerobic layer can develop over the sediments if the lake becomes temporarily thermally stratified during quiet atmospheric periods. As thermal stratification breaks down and vertical mixing to the bottom is reestablished, dissolved phosphorus released from the sediment is delivered to the trophogenic zone. Conditions in Lake Ronkonkoma were ideal for temporary thermal stratification during early August, 1983. In mid-August, the temporary stratification broke down, then was reestablished by the end of August. Again in late September, the epilimnion extended to the bottom over the greatest area of the lake. Cycles of temporary thermal stratification can provide sufficient dissolved phosphorus for an algal bloom in the epilmnion, especially if the hypolimnetic volume during stratification is small relative to the surface area of sediment, as in Lake Ronkonkoma (see Golterman, 1973; Premazzi, et. al., 1984; Barica, 1974; and others).

One final supplemental source of dissolved phosphorus in Lake Ronkonkoma may be found in the areas of groundwater underflow into the lake, and lake underflow (outflow) back to the groundwater flow system. Liere and Mur (1982) demonstrated release of dissolved phosphorus from sediments into the water column as water moved through the sediment, in response to a concentration gradient. Yet, the areas of underflow of Lake Ronkonkoma can serve as an additional source of dissolved phosphorus not encountered in most other north temperate lakes.

The magnitude of mean TP concentrations can also appear deceptively low for prediction of chlorophyll **a** concentration if the recycling of dissolved nutrients within the trophogenic zone is sufficiently rapid. Zooplankton species composition and community size structure can influence recycling rates of nutrients, while the abundance of the zooplankton can affect the total quantity of nutrients recycled over time. For example, Korstad (1983) measured nutrient regeneration in the zooplankton community as a whole and found replenishment of dissolved phosphorus available for algal growth in less than 70 hours. Moreover, Henry (1985) determined that zooplankton communities dominated by smaller sized species, such as *Bosmina, Chydorus* and *Ceriodaphnia* (species which were most often dominant in Lake Ronkonkoma), cycled more phosphorus than those composed of larger species. Using the size specific phosphorus excretion rates measured by Ejsmont-Karabin (1984) for well fed zooplankton, Ceriodaphnia recycled 4.8 μg P-PO_4/l/day in mid-July, 1983 when it was the dominant species. Daphnia, the largest herbivorous species in mid-July, recycled 0.85 μg P-PO_4/l/day. The total recycled by the two species, 5.65 μg P-PO_4/l/day, accounted for more than 75% of the static dissolved phosphorus concentration measured in Lake Ronkonkoma in mid-July, 1983. Hence, it can be deduced that more dissolved phosphorus was available for algal growth through time via remineralization than was apparent in the concentration of TP or dissolved phosphorus measured at any one time.

The high mean chlorophyll **a** concentrations per unit TP may also have been partially due to unusually (but not uniquely) high cellular chlorophyll **a** content. The chlorophyll **a** content per algal cell may have been influenced by the multiple, successive *blooms* of algal species, or groups of species, in Lake Ronkonkoma during the summer of 1983. When a bloom is developing, the phytoplankton species which constitute(s) the bloom exhibit log-phase, or rapid growth for periods lasting days or longer. During the rapid growth phase, when neither light or nutrients are limiting, chlorophyll **a** content per cell volume can be much higher than at times of moderate or replacement growth, or decline (See Nicholls and Dillon, 1978, and references cited therein). At any one sampling time, the dominant phytoplankton population, or a relatively large proportion of the phytoplankton community, was likely to be in the rapid growth phase in Lake Ronkonkoma during the summer of 1983.

The summer phytoplankton of Lake Ronkonkoma also spend part of the time under low light intensities due to the depth of vertical mixing. In Lake Ronkonkoma, the mean depth of the euphotic zone (i.e. depth of 1% of surface light intensity) during the summer of 1983 was three meters, based on Secchi disk measurements. At the same time, the vertically mixed layer extended to the six meter depth (four meter depth on one sampling date). Therefore, phytoplankton in the water column were transported into and out of the euphotic zone within the epilimnion due to the physical forces of mixing. The length of time spent at depths of low light intensity for each phytoplankton cell would depend on the intensity and duration of vertical mixing. The relevance of the position of phytoplankton cells in the water column is that cellular chlorphyll **a** content can be inversely dependent on light intensity. Cells grown at low light intensities, or shaded, have contained greater chlorphyll **a** content than those grown under more favorable light intensities (see Nichous and Dillon, 1978, and references cited therein). Unusually high chlorophyll **a** content per cell volume as a consequence of exposure to low light intensities could have contributed to the unexpectedly high Chl **a**/TP in Lake Ronkonkoma.

The Chl **a**/TP is of more importance than academic interest here. It has been a common lake management practice in recent years to use the generalized Chl**a**/TP as a tool upon which to base management decisions. In order to reverse eutrophication, for example, elimination of nutrient influx has very often been the focus of lake rehabilitation efforts. The Chl **a**/TP can be used to predict and evaluate the response of algal biomass, and therefore trophic status, to the control of phosphorus influx from the watershed.

Eliminating the phosphorus influx would ultimately prevent an increase in the total amount of phosphorus in the lake for the future. For the short term, the impact of the phosphorus influx on the algal biomass cannot be defined. A response in algal biomass, either as lag-time or quantity, to elimination of phosphorus influx is unpredictable.

Lake Ronkonkoma very likely contains phosphorus enriched sediments. Coupled with the depth of the vertical mixing relative to the depth of the greatest area of sediment surface, the enriched sediments serve as a continuous phosphorus source during the summer. To determine the most effective, direct means of controlling phosphorus availability for algal growth (i.e. reverse eutrophication), the magnitude of internal phosphorus loading has to be determined. Unfortunately, simple chemical treatment of the sediments, for example application of alum, for the purpose of eliminating internal loading is not feasible in Lake Ronkonkoma. Again, the depth of mixing relative to the bottom makes it very unlikely that a stable chemical seal could be achieved. Attempts to chemically seal the sediments would yield unpredictable results.

The ultimate visible goal of reversing eutrophication is to decrease the algal biomass and thereby increase water clarity. Prevention is not the only means of controlling algal biomass. Consumption of algal cells can achieve the same control of algal biomass, and thereby water clarity, as prevention of growth.

In Lake Ronkonkoma, greater consumption of algal cells, especially during the early summer, might be accomplished by altering the size composition of the zooplankton community (a type of biomanipulation). The Daphnia species (D. retrocurva, D. catawba, D. parvula, D. galeata), which were present at reduced numbers during the 1983 summer, can consume greater quantities of algal cells per individual and rely more directly on the living algal cells for nutrition than do the smaller, dominant species (Bosmina, Chydorus, Ceriodaphnia) in Lake Ronkonkoma.

The larger zooplankton herbivores, if dominant, would recycle phosphorus at a slower rate than the smaller species exerting a growth control on the phytoplankton. The zooplankton community size structure (relative to species abundance) can be manipulated by restructuring the fish populations, a not uncommon fisheries management procedure. For example, if the smaller planktivorous fish in Lake Ronkonkoma were cropped to a lower total biomass, predation pressure on the larger herbivorous zooplankton would ease, and thereby result in expansion of those algal consuming populations (see Shapiro, et. al., 1976, and references cited therein). Greater grazing pressure on the phytoplankton during June and July may also maintain the pH low enough to prevent the heavy blue-green algal blooms during August. Lake Ronkonkoma provides greater control than most lakes for fisheries population manipulation since it has no surface outlet.

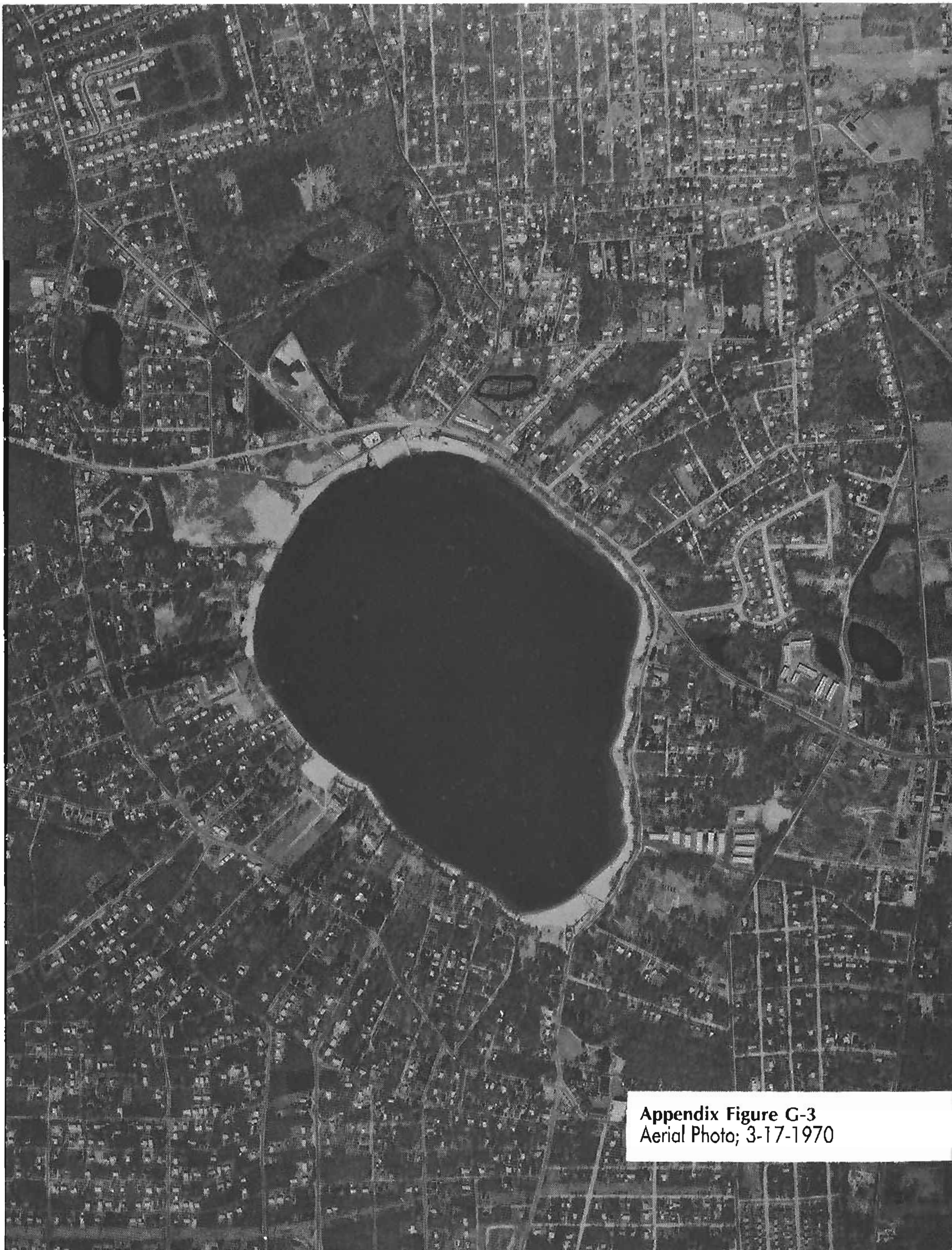
Appendix G

Appendix Figure G-1	-	circa 1930 - 1933
Appendix Figure G-2	-	9-23-47
Appendix Figure G-3	-	3-17-70
Appendix Figure G-4	-	3-23-80

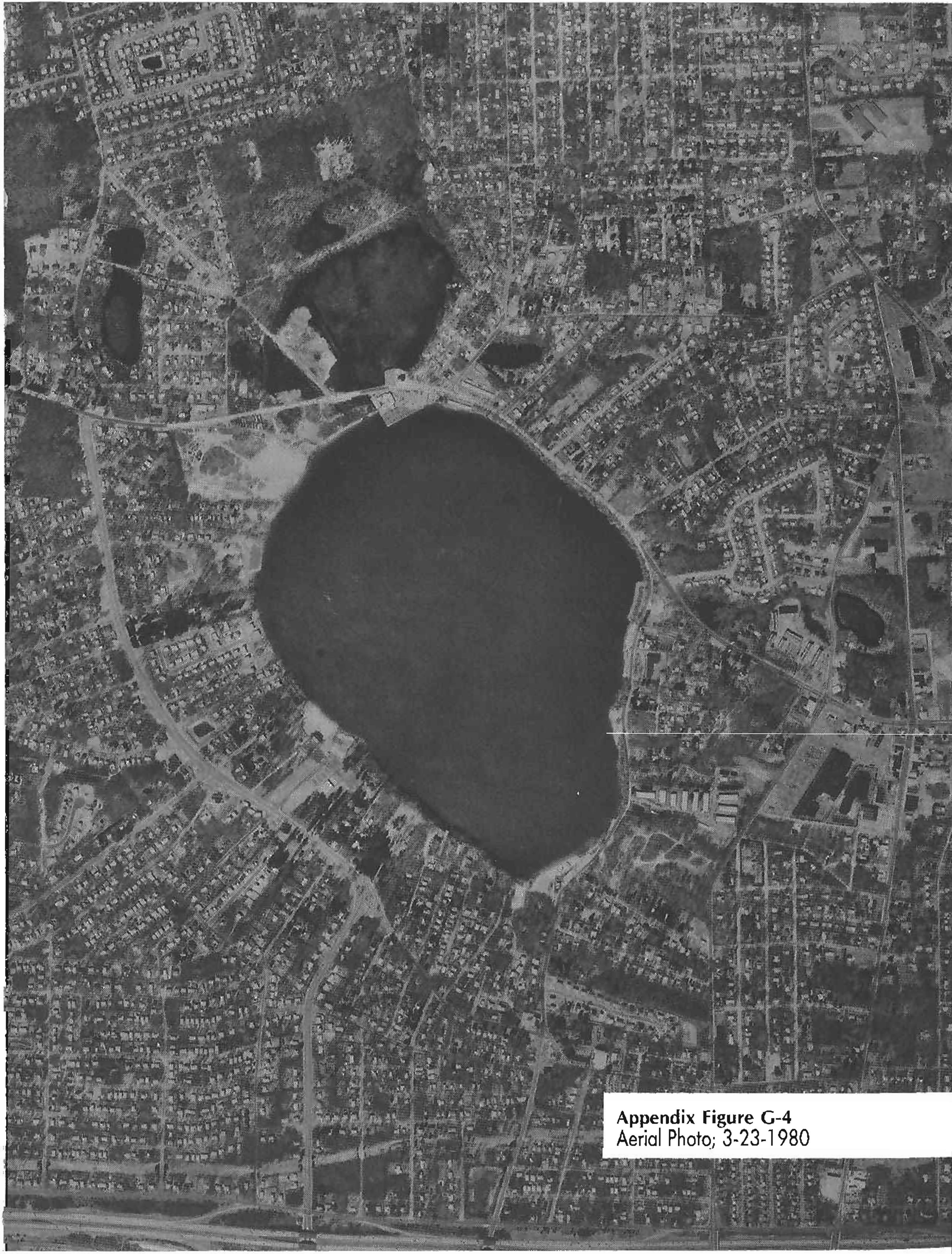
(See Figure 2-10 for Aerial Dated 4-21-84)

Appendix Figure G-1
Aerial Photo; circa 1930-1933

Appendix Figure G-2
Aerial Photo; 9-23-1947



Appendix Figure G-3
Aerial Photo; 3-17-1970



Appendix Figure G-4
Aerial Photo; 3-23-1980